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Caroline Beaverhill Lake Gas Development Applications

CANADIANA
SEP 12 1990

Shell Canada Limited
Husky Oil Operations Ltd.

August 1990

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CAROLINE BEAVERHILL LAKE GAS DEVELOPMENT APPLICATIONS
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1 INTRODUCTION

1.1 Background

The Caroline Beaverhill Lake gas reservoir was discovered by Shell Canada Limited (Shell) in January of 1986. The reservoir is in the Swan Hills Member of the Beaverhill Lake Formation at a depth of close to 4000 metres (m). The reservoir contains an estimated 56 billion standard cubic metres (m^3) of gas which has an average hydrogen sulphide (H_2S) concentration of 35 per cent and also a high content of condensate and other natural gas liquids. Presently there are 18 wells drilled into the pool.

In late 1987, the reservoir owners, led by Shell, Gulf Canada Resources Limited (Gulf), and Canterra Energy Ltd. (subsequently Husky Oil Operations Ltd. (Husky)), joined together as the Caroline Area Gas Development Group (CAGDG) to prepare a co-ordinated development plan for the Caroline gas reserves.

In December 1988, CAGDG put forward a draft proposal called the Selected Development Option, under which about one-third of the Caroline gas would be pipelined northward to the existing Husky Ram River and Gulf Strachan gas plants, and the remainder would be processed at a new gas plant to be constructed near the Caroline field.

In March 1989, Husky advised CAGDG that it would no longer support the Selected Development Option because it believed the scheme would create greater environmental impacts, and was receiving public opposition. Subsequently, in July 1989, Shell applied on behalf of itself and all the Caroline working interest owners, except Husky, for approval to construct a new gas plant located near the field (Site E) to process all of the Caroline gas reserves. Shortly thereafter, Husky applied for approval to process all of the Caroline gas at its Ram River gas plant which it proposed to expand. Husky's proposal also included the construction of a gas transmission plant at Site E and gas transmission pipelines from Site E to Ram River.

During the latter part of 1989 and early 1990, Shell and Husky submitted additional documents to complete and support their respective applications.

Figure 1 shows the general area of the Caroline gas field, the location of some of the major facilities proposed by the applicants, and certain significant geographic features. The field is located in a farming, ranching and recreational-use area, close to the Green Area (provincial forest reserve).

During the formulation of the Selected Development Option, and subsequently the separate Shell and Husky proposals, the proponent companies communicated with the local public through numerous open houses, meetings, and mailings. This resulted in a number of local groups becoming involved, including the following:

- The Caroline Advisory Board (CAB) which was formed in January 1988 to represent municipalities and local residents in the project region.
- The Burnstick Lake Cottage Owners' Association (BLCOA) was in existence prior to the Caroline discovery, representing 57 cottage owners at Burnstick Lake, located some 6.5 kilometres (km) northwest of the proposed Shell and Husky gas plant location at Site E.
- The Preservation of Agriculture and Living Space Society (PALSS) which was formed in January 1989, representing residents and landowners largely in the Bearberry area west and northwest of the town of Sundre.

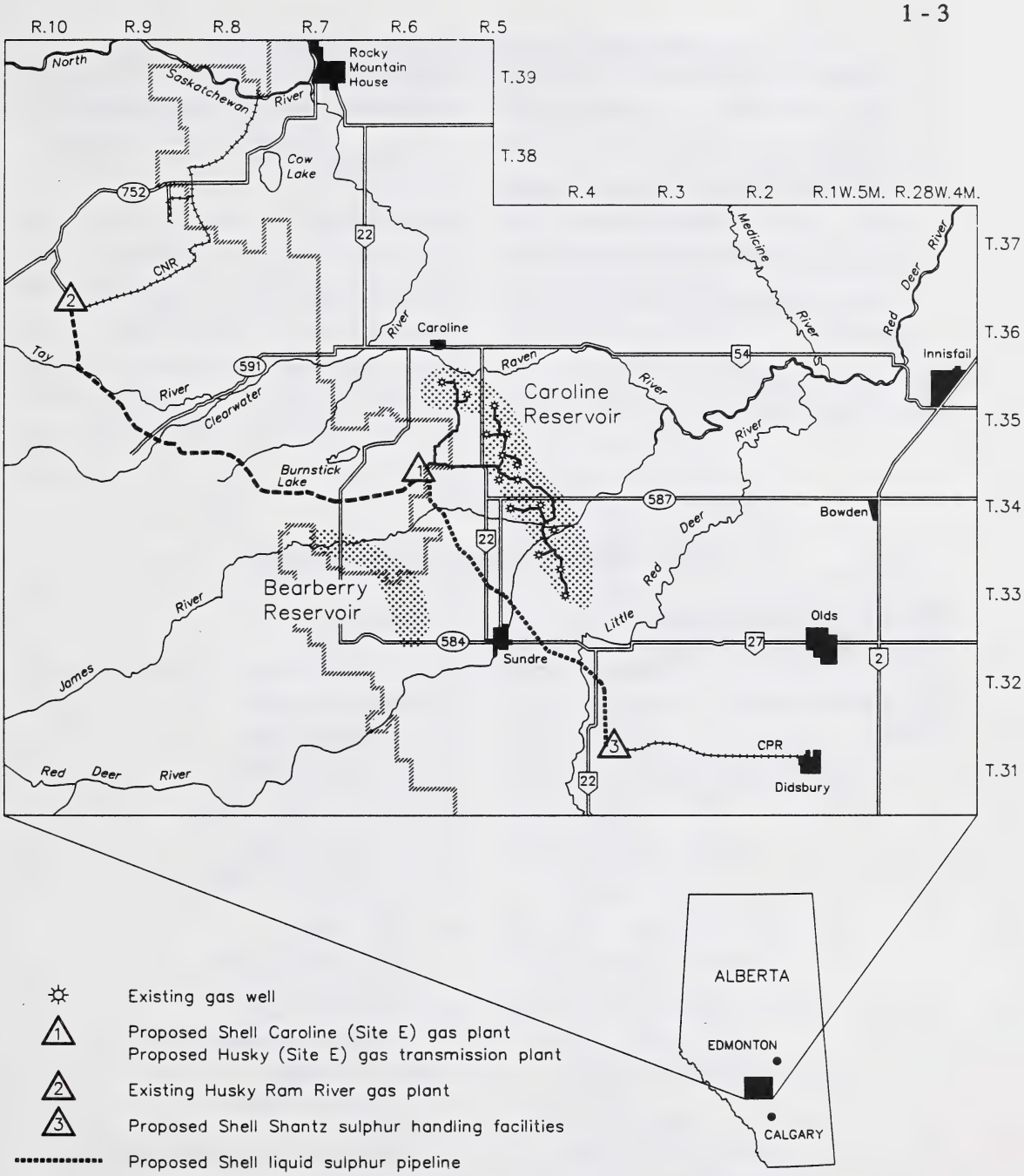


FIGURE 1 CAROLINE REGION

- The Concerned Residents Action Group (CRAG) which was formed in September 1989, representing 43 families in the immediate area of the Shell and Husky proposed gas plant sites (Site E).
- The Mountain View Land Holders Group which was in existence prior to the Caroline discovery, representing residents and landowners in the Eagle Valley area near the southern portion of the Caroline gas field.

A prehearing meeting was convened by the Energy Resources Conservation Board (the Board) in Caroline on 30 January 1990 to establish the date and location for the hearing of the Caroline development applications.

1.2 Hearing

The applications were considered by the Board at a public hearing in Caroline, Alberta, commencing on 17 April 1990 and continuing to 10 May 1990, with G.J. DeSorcy, P.Eng., F.J. Mink, P.Eng., and B.F. Bietz, Ph.D., sitting. Final argument was heard in Caroline on 28 and 29 May 1990. Those who participated at the hearing are listed in **Table 1**.

TABLE 1

THOSE WHO APPEARED AT THE HEARING

Principals and Representatives (Abbreviations Used in Report)	Witnesses
Shell Canada Limited (Shell) D. O. Sabey, Q.C. J. E. E. Lowe	R. Woods, P.Geoph. L. E. Auger, P.Eng. W. W. Evans, P.Eng. W. D. McQuitty, P.Eng. R. W. P. Symonds, P.Eng. W. S. Welling, P.Eng. R. M. Wrubleski, P.Eng. all of Shell Dr. F. G. Bercha of F.G. Bercha and Associates (Alberta) Limited Dr. T. L. Dabrowski of Piteau Engineering Ltd. Dr. D. M. Leahey of Western Research J. A. Lore of Jim Lore & Associates Ltd. D. B. Ramsay of Ramsay and Associates Consulting Services Ltd. W. M. Veldman, P.Eng. D. E. Reid both of Hardy BBT Limited

THOSE WHO APPEARED AT THE HEARING (cont.)

Principals and Representatives (Abbreviations Used in Report)	Witnesses
	D. A. Young of Environmental Management Associates A. B. Coady, P.Eng. of Delta Projects Inc. (Delta) W. B. Friedenberg of Brent Friedenberg Associates Ltd.
Husky Oil Operations Ltd. (Husky) A. L. McLarty R. A. Neufeld S. Purcell	A. R. Price, P.Eng. D. J. Ferris, P.Eng. J. D. Kingsbury, P.Eng. M. D. Little, P.Eng. R. Manning D. A. McCoy J. L. Milne, P.Eng. J. Uncles, P.Eng. B. W. Worbets all of Husky D. L. Dabbs M. J. E. Davies R. V. Portelli, P.Eng. J. A. Smith M. J. Zelensky, P.Eng. all of Concord Scientific Corporation Dr. D. A. Hackbarth of Stanley Associates Engineering Ltd. Dr. H. J. Ruitenbeek of H. J. Ruitenbeek Resource Consulting Limited H. G. Pearce D. W. Schwanbeck both of The Coopers & Lybrand Consulting Group P. K. Symborski, P.Eng. of Symborski & Associates Ltd. Dr. D. Maynard Dr. K. Mallett both of Forestry Canada

THOSE WHO APPEARED AT THE HEARING (cont.)

Principals and Representatives (Abbreviations Used in Report)	Witnesses
	A. Blair, P.Eng. M. Potter, P.Eng. R. Stothard all of Fluor Daniel Canada Inc.
Federated Pipe Lines Ltd. (Federated) A. S. Hollingworth	J. Sim M. J. Massecar, P.Eng. R. W. McKay, P.Eng. all of Home Oil Company Limited K. Gilmore of Tera Environmental
Amoco Canada Petroleum Company Ltd. (Amoco) V. J. Carson	D. English, P.Eng.
Altana Exploration Company (Altana) W. H. Schlieman	H. Heise, P.Eng.
ATCOR Ltd. (ATCOR) G. Chury	G. Chury
Canadian Hunter Exploration Ltd. (Canadian Hunter) J. Ballem, Q.C. R. Hansford	J. A. Dillabough, P.Eng.
Gulf Canada Resources Limited (Gulf) D. Gandar	D. Lovitt, P.Eng.
Mobil Oil Canada (Mobil) L. Anderson	L. Anderson
NOVA Corporation of Alberta (NOVA) H. D. Williamson	S. Senger

THOSE WHO APPEARED AT THE HEARING (cont.)

Principals and Representatives (Abbreviations Used in Report)	Witnesses
Numac Oil & Gas Ltd. (Numac) J. H. Pletcher	J. H. Pletcher, P.Eng.
Union Pacific Resources Inc. (Union Pacific) J. Curran	B. Bowersock, P.Eng. N. Gundeson, P.Eng. T. Wiechart, P.Eng.
CN Rail (CN) J. J. Marshall, Q.C. M. Comeau C. Craig	J. Guppy, P.Eng.
CP Rail (CP) M. M. Szel P. Guthrie	M. Dugas
Alberta Fish and Game Association I. Johannson	I. Johannson
Pollution Sub-Committee of the Public Advisory Committees - Environment Council of Alberta P. Ramalingam	Dr. P. Ramalingam
J. Bauman L. Bauman	Dr. J. Bauman Dr. L. Bauman
R. and R. Brown and H. McCormick	R. Brown
J. and L. Brunner R. Heggie	J. Brunner L. Brunner
Burnstick Lake Cottage Owners' Association (BLCOA) J. Slavik W. L. McElhanney	D. Auld Dr. R. Rowe Dr. J. Whittaker

THOSE WHO APPEARED AT THE HEARING (cont.)

Principals and Representatives (Abbreviations Used in Report)	Witnesses
Caroline Advisory Board (CAB) J. D. Rooke, Q.C.	R. Brown K. Guenther R. King J. Macklin K. Turnbull S. Vollmin
Caroline & District Chamber of Commerce R. Bancroft	R. Bancroft
Concerned Residents Action Group (CRAG) N. K. Machida	D. Brown J. Crozier P. Dahlman S. Johnston M. Taylor D. Willsie all members of CRAG Dr. B. Horejsi of OK Biological Services Ltd. B. Leach, P.Eng. of Golder Associates Ltd. N. McNally of McNally Land Services Ltd. L. Morasch, P.Eng. of Morasch Transportation Consultants Ltd. W. Roberts of the University of Alberta M. Thompson, P.Eng. of Nanuk Engineering Ltd. Dr. A. Younger of SKM Consulting Ltd.
County of Mountain View No. 17 S. Vollmin	S. Vollmin
Diamond J. Industries Ltd. J. Bandura	J. Bandura

THOSE WHO APPEARED AT THE HEARING (cont.)

Principals and Representatives (Abbreviations Used in Report)	Witnesses
D. and M. Harris	D. Harris
J. Hermann	J. Hermann
E. and B. Jans	E. and B. Jans
M. Kostuch and the Rocky Veterinary Clinic Ltd. (RVC) R. D. Schachter	Dr. M. Kostuch T. Bouman
J. and B. Macklin	J. Macklin
Mountain View Land Holders Group (Mountain View) M. Sihlis	M. Sihlis K. Jorsvick B. Macklin
Olds & District Chamber of Commerce J. Smith	J. Smith
Preservation of Agriculture and Living Space Society (PALSS) K. F. Miller G. T. H. Locke	A. Bakken T. Guzmanuk N. Stringer K. Walker all members of PALSS B. Parrott Dr. N. Zorkin both of Norecol Environmental Consultants Ltd. (Norecol)
Rocky Mountain House & District Chamber of Commerce P. Wasyk	P. Wasyk
L. and S. Roth	S. Roth
D. Saunders and 447 Area Residents D. Saunders	D. Saunders

THOSE WHO APPEARED AT THE HEARING (cont.)

Principals and Representatives (Abbreviations Used in Report)	Witnesses
Sundre & District Chamber of Commerce D. Dewinetz	D. Dewinetz
Town of Innisfail P. Newman	P. Newman
Town of Rocky Mountain House T. Machan	T. Machan
Town of Sundre K. Guenther T. Leslie	K. Guenther
Village of Caroline D. Chapman	D. Chapman
R. E. Wolf	R. E. Wolf
Alberta Environment staff J. Lack, P.Eng. R. Stone C. S. Liu, P.Eng. B. MaGill K. Lowe S. Sakiyama, P.Eng.	
Energy Resources Conservation Board staff M. J. Bruni H. R. Keushnig, P.Eng. R. Creasey Dr. F. Rahnama T. Pesta, P.Eng. M. Semchuck D. Hubensky V. Makwich R. Palmer M. Pinney J. Wickens	

J. Dziadek appeared at the hearing and conducted cross-examination only, but did not present evidence or final argument.

The following filed interventions in support of Shell, but did not appear at the hearing:

DEKALB Energy Canada Ltd.
Home Oil Company Limited
Norcen Energy Resources Limited
PanCanadian Petroleum Limited
G. E. Allison Construction Ltd.
Sundre Emergency Medical Society
Sundre General Hospital
A. Macklin

The following filed interventions which did not support or oppose either applicant and did not appear at the hearing:

A. Ludwig
Municipal District of Clearwater No. 99

2 APPLICATIONS

2.1 Introduction

This section of the report summarizes the applications before the Board, and Section 3 summarizes the positions taken by the various interveners at the hearing. The information provided by participants was detailed and extensive, and is only briefly summarized in this report. The Board recognizes that its written summary may omit some matters considered important by others, but emphasizes that it has reviewed all of the evidence before it in reaching its conclusions.

2.2 Shell and Working Interest Owners

Shell submitted its applications on behalf of itself and, with the exception of Husky, all of the other working interest owners (Owners) of the Caroline Beaverhill Lake gas reserves as listed in **Table 2**. Together with Shell these Owners represent more than 88 per cent of the working interest of the Caroline Beaverhill Lake reserves.

Shell's proposal consisted of 14 individual applications filed by Shell and 3 associated applications which were filed by other applicants. A schematic map of the facilities is shown in **Figure 2** and the applications relating to Shell's project are listed in **Table 3**.

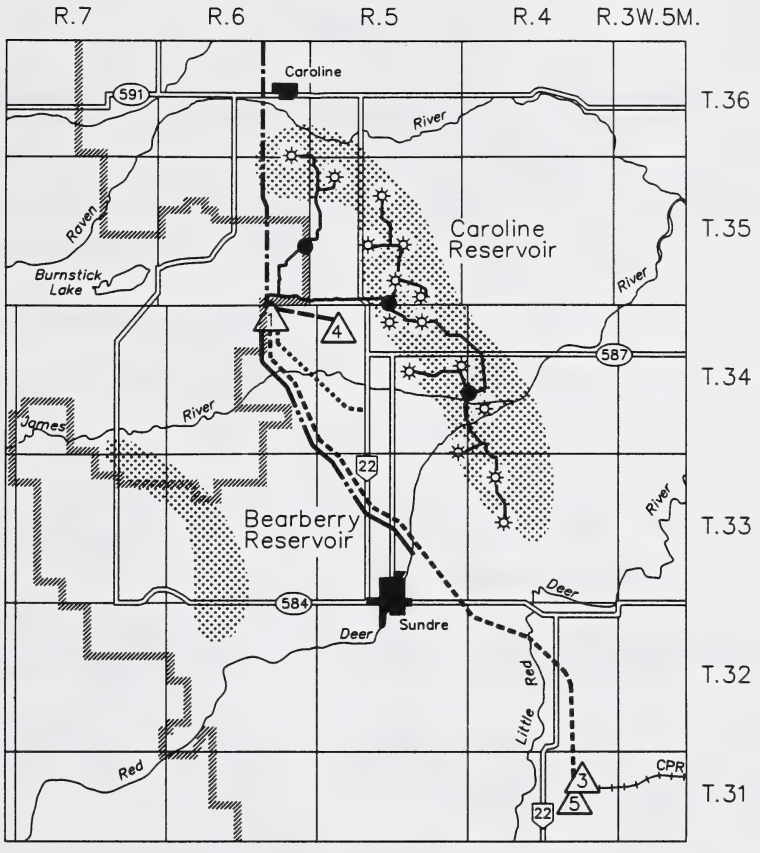
The Shell project would be comprised of the following four main components:

- the field gas gathering system consisting of 15 wells and 3 field compressor stations,
- a sour gas processing plant (Site E),
- a liquid sulphur pipeline system from Site E to Shantz, and
- sulphur forming and handling facilities at Shantz.

TABLE 2

WORKING INTEREST OWNERS
SHELL APPLICATION

Altana Exploration Company	(Altana)
ATCOR Ltd.	(ATCOR)
DEKALB Energy Canada Ltd.	(DEKALB)
Gulf Canada Resources Limited	(Gulf)
Home Oil Company Limited	(Home)
Mobil Oil Canada	(Mobil)
Norcen Energy Resources Limited	(Norcen)
Numac Oil and Gas Ltd.	(Numac)
PanCanadian Petroleum Limited	(PanCanadian)
Precambrian Shield Resources Limited	(Precambrian)
Scurry-Rainbow Oil Limited	(Scurry-Rainbow)
Shell Canada Limited	(Shell)
Esso Resources Canada Limited (Texaco Canada Resources)	(Esso)
Union Pacific Resources Inc.	(Union Pacific)



- Compressor station
- Existing gas well
- Proposed Shell Caroline (Site E) gas plant
- Proposed Shell Shantz sulphur handling facilities
- Existing Altana Caroline gas plant
- Existing Mobil Harmattan gas plant
- Proposed Shell liquid sulphur pipeline system
- Proposed Shell gas gathering system
- Proposed Shell fresh water pipeline
- Proposed Amoco condensate pipeline (connects to Rangeland system)
- Proposed Federated natural gas liquid pipeline
- Proposed Shell/Altana acid gas pipeline
- Alberta Green Area boundary

FIGURE 2 SHELL DEVELOPMENT PROPOSAL CAROLINE BEAVERHILL LAKE GAS RESERVOIR

TABLE 3

APPLICATIONS FOR SHELL'S PROPOSED DEVELOPMENT

Application Number	Facility	Facility Location			
		Sec	Twp	Rge	Meridian
890969	gas plant (Site E)	34&35	34	6	W5
891504	North compressor station	13	35	6	W5
891505	Central compressor station	33	34	5	W5
891506	South compressor station	18	34	4	W5
891478	Sour gas gathering pipeline system	from: 15 producing wells in the Caroline field to: proposed gas plant			
891479	Sour liquids gathering pipeline system	from: three proposed compressor stations to: proposed gas plant			
891480	Sweet fuel gas pipeline system	from: proposed gas plant to: 15 producing gas wells and other related facilities in the Caroline field			
891481	Fresh water pipeline	from: 19	34	5	W5 (James River)
		to: proposed gas plant			
891482	Salt water pipeline system	from: three proposed compressor stations			
		to: 30	34	4	W5
		from: proposed gas plant			
		to: 29	34	5	W5
891568	Fresh water pipeline	from: 15	33	5	W5 (Red Deer River)
		to: proposed gas plant			
891569	Sulphur product pipeline	from: proposed gas plant			
		to: 35	31	4	W5 (proposed Shantz sulphur forming facilities)

TABLE 3

APPLICATIONS FOR SHELL'S PROPOSED DEVELOPMENT (cont.)

Application Number	Facility		Facility Location Sec	Twp	Rge	Meridian
891570	Sweet fuel gas pipeline	from:	proposed gas plant			
		to:	proposed Shantz sulphur forming facilities			
891571	Hot water pipeline	from:	proposed Shantz sulphur forming facilities			
		to:	proposed gas plant			
900404	Acid gas gathering pipeline	from:	36	34	6	W5
		to:	proposed gas plant			
891483(1)	Natural gas liquids pipeline	from:	proposed gas plant			
		to:	17	47	27	W4
891290(2)	Condensate pipeline	from:	proposed gas plant			
		to:	8	34	5	W5
900236(3)	Compressor addition		To be installed at Altana's gas plant at			
			36	34	6	W5

(1) Application submitted by Federated.
(2) Application submitted by Amoco.
(3) Application submitted by Altana.

2.2.1 Field Production Facilities

Wells

The Shell development would include the initial tie-in of 15 existing production wells. Ultimately, a total of 20 to 30 wells are anticipated to be tied in over the life of the field. Each well would have a subsurface safety valve (SSSV) installed near the top of the production tubing string, and would be designed to automatically shutoff flow from the well in the event of a surface facility failure or flow-line disruption. This valve would be tested regularly to ensure safe operation. Each wellhead would be equipped with two master valves for redundancy and a wing valve. In addition to the SSSV, each well site would have three other automatic control valves including the following:

- one emergency shutdown (ESD) valve at the wellhead,
- a second ESD valve installed downstream of the well-site heater, and
- a flow control valve (choke) installed between the coils in the well-site heater.

Like the SSSV, the ESD valves would be designed to close automatically in the event of abnormal conditions. A field control system would provide continuous monitoring of the field operating conditions to the proposed Shell gas plant control room. Alarms would alert the operators of any unusual situations and the safety valves could be activated remotely.

Gathering System and Field Compression

Raw[1] multi-phase (gas, oil, and water) production from each well would flow to one of three field compressor stations (South, Central, or North) where it would be separated into water, a single-phase sour[1] liquid stream and a single-phase sour gas stream. The produced water would be sent to a disposal facility for deep well injection. The single-phase sour liquids and the raw sour gas volumes would be piped in separate lines from the compressor stations to Shell's proposed Caroline gas processing plant at Site E.

Shell's gathering system would include 114.3-millimetre (mm) to 406.4-mm outside diameter (OD) pipelines, line block valves, pigging facilities (for cleaning the lines), a computerized Supervisory Control and Data Acquisition (SCADA) system, and a high-pressure sweet gas distribution system back to each well, field compressor, and other field facilities for lease fuel and purging. Shell applied to install a total of 72 automated line block valves, including those located at the compressor stations, at field pipeline junctions, and at its proposed plant, which would be situated at 31 locations in the gathering system. The compressor stations would be equipped with raw gas, raw liquid, and produced waterseparation facilities, a three-phase test separator, electric-drive compression for the raw gas volumes, liquid pumping equipment, produced water handling facilities, computerized SCADA system, emergency flare facilities, and related utilities.

The sour service pipelines would be designed to meet or exceed Level 3 requirements which are described in ERCB Interim Directive *ID 81-3*[2]. Shell incorporated a number of other design features to ensure greater safety, including:

- installing and operating the proposed compressor stations at the start of field production, which would allow the gathering pipelines upstream of the compressor stations to operate at pressures of 3500 to 4000 kilopascals (kPa) instead of at the wellhead pressure of 9000 kPa. The reduced pressure would significantly reduce the potential H_2S release volume in the event of a pipeline release;
- using a pipe-wall thickness at least twice that required by current regulations;
- installing a comprehensive leak detection and monitoring system. (This is further discussed in Section 9 of this report.)

Shell stated it had obtained pipeline easements from all the affected landowners and occupants for its proposed gathering system.

2.2.2 Gas Processing Plant (Site E)

Shell stated that its proposed Caroline gas plant would be designed to process a maximum of 9435 thousand cubic metres per day (10^3 m^3/d) of raw gas and gas equivalent of associated hydrocarbon liquids. At this design rate, Shell's total plant feedstock,

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(1) "Raw" means the unprocessed production and "sour" indicates that the streams would contain some H_2S and other sulphur compounds.

(2) ERCB Interim Directive *ID 81-3* Minimum Distance Requirements Separating New Sour Gas Facilities from Residential and Other Developments.

which would include Altana's acid gas, would which is equivalent to 4513 tonnes per day (t/d) of sulphur.

Shell stated that its proposed plant would be designed to meet the Board's current sulphur recovery requirement[3] which, for new plants with a maximum sulphur inlet rate of 2000 t/d or greater, is 99.8 per cent. Based on this minimum sulphur recovery efficiency, at design throughput rates, Shell's proposed plant would emit a maximum of 18 t/d of sulphur dioxide (SO_2) or 9 t/d sulphur equivalent to the atmosphere through an 85-m incinerator stack. Shell indicated that its expected annual average SO_2 emissions would be about 16.3 t/d or 8.1 t/d sulphur equivalent.

Shell's gas processing plant would consist of the following:

- inlet separation,
- condensate stabilization,
- compression (recycle and sales gas),
- gas sweetening (Sulfinol) for H_2S and carbon dioxide (CO_2) removal,
- dehydration,
- cryogenic natural gas liquids (NGL) recovery,
- Claus sulphur recovery units,
- Shell Claus Offgas Treating (SCOT) tail gas clean-up units,
- sulphur degassing and liquid sulphur pumping,
- NGL and stabilized condensate storage,
- waste water treatment, handling, and deep well disposal, and
- utilities and offsites.

All sour service components and processing facilities would be constructed in two equivalent parallel trains. (Plant design is discussed further in Section 6 of this report.)

2.2.3 Liquid Sulphur Pipeline System

Shell said it would use the Shell Sulphur Degasification Process at its Site E plant for degassing the produced sulphur. Entrained gas would be taken out of the liquid sulphur in sulphur degassing pits at Shell's proposed plant, reducing the H_2S content from 350 parts per million (ppm) to less than 10 ppm. At the request of area residents, Shell modified its gas plant application and eliminated the provision of an emergency sulphur block at the proposed Site E plant. There would be limited storage for approximately 8000 tonnes (t) of liquid sulphur which would be stored in above-ground covered storage tanks at the Site E plant. Provisions would be made to transport the liquid sulphur to Shantz by trucking in emergency situations.

The degassed liquid sulphur would normally be pumped directly 40 km from Shell's Site E gas plant to its proposed sulphur forming facilities at Shantz through an insulated 219.1-mm OD steel pipeline buried 1 m below ground. The temperature of the sulphur would be maintained at approximately 122 to 130 Celsius (°C) using pressurized hot water treated with corrosion inhibitors, pumped through an external 323.9-mm OD casing (jacket) surrounding the sulphur pipeline.

Three combined heater and water pumping stations would be required, one at Shell's proposed Site E plant and the other two at 14-km intervals along the pipeline. A 168.3-mm OD insulated hot water return pipeline would parallel the sulphur pipeline to permit circulation of the hot water.

The liquid sulphur pipeline would be designed to accommodate internal pipeline inspection

(3) Energy Resources Conservation Board and Alberta Environment, August 1988. Sulphur Recovery Guidelines for Sour Gas Plants in Alberta, Informational Letter *IL 88-13*.

tools for corrosion monitoring. The whole pipeline would be encased in a water-tight polyethylene pipe to prevent external corrosion. Shell would utilize a SCADA system, integrated with the Site E gas plant control room to ensure safe operation and continuous control of the liquid sulphur pipeline system. Shell would install ESD valves at strategic locations on the line so that in the unlikely event of a leak, the portion of the disabled line could be closed to minimize the spill volume. Since the liquid sulphur pipeline would be enclosed by the hot water jacket, no sulphur would escape unless all the lines ruptured. Shell would also conduct regular visual inspections along the pipeline route. Shell stated that the liquid sulphur pipeline system, like the rest of its pipelines in the Caroline development, would have all critical systems designed for fail-safe operation[4].

Shell advised that it had acquired easements from all the affected landowners and occupants for its proposed liquid sulphur pipeline system.

2.2.4 Sulphur Forming and Handling Facilities

To accommodate the sulphur that would be produced at its proposed Site E gas plant, Shell applied to construct new sulphur forming, handling, storage, and loading facilities at Shantz in the southwest quarter of section 35, township 31, range 4, west of the 5th meridian (SW 1/4-35-31-4 W5M), which would be adjacent to Mobil's existing Harmattan sulphur recovery plant. The liquid sulphur would be formed into small spherical pellets at Shantz using the Sandvik Rotoforming process. Shell stated that it selected this process because it produces a product of low friability (ie. not easily crumbled), with a minimal sulphur dust created during forming, loading, and shipping.

Shell proposed to install storage facilities for 30 000 t of formed sulphur and 12 000 t of liquid sulphur storage capacity at Shantz. Shell added that only if there were extended disruptions to its normal sulphur shipping and marketing schedule would it pour sulphur to block at Shantz. Shell emphasized that it would not pour sulphur to block at its proposed Caroline gas plant at Site E.

A CP spur would be constructed from Mobil's existing facilities to Shell's sulphur forming, storage, and loading equipment. Shell stated it selected CP over CN because its route to Vancouver is 40 per cent shorter (1168 km versus 1624 km), and claimed this resulted in considerable cost and energy savings.

2.2.5 Hydrocarbon Product Pipelines

The Federated, Amoco, and NOVA product pipelines that would be required for Shell's development are described in Sections 2.4 and 2.5.

2.2.6 Altana Acid Gas

Shell applied to construct an acid gas pipeline that would transport acid gas from Altana's plant in 12-36-34-6 W5M (12-36) to Shell's proposed Caroline plant for sulphur recovery. Altana's plant is presently licensed to emit up to 5.9 t/d of SO_2 and currently flares all of its acid gas. By processing the acid gas and recovering the sulphur, Shell stated this would assist in improving the ambient air quality in the area by eliminating the Altana plant's current SO_2 emissions.

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(4) The facilities would be designed to automatically shutoff flow from a well or pipeline in the event of a wellhead or pipeline disruption.

Altana submitted a related application wherein it proposed to install a compressor at its 12-36 plant which is necessary to deliver the acid gas to Shell's proposed facilities.

2.2.7 Infrastructure

Roads

Shell planned to share in a program of road upgrading in the Caroline area with the MD of Clearwater No. 99 and Alberta Transportation. The upgrading program would include a 4.8-km paved extension west of Secondary Road (SR) 587 and a 14-km upgrade of the road from the Village of Caroline to its proposed Site E gas plant.

Electric Power

Shell estimated that approximately 20 megawatts (MW) of power would be required from TransAlta Utilities Corporation (TransAlta) for its proposed gas plant, sulphur pipeline system, and sulphur forming facilities. Another 32 MW would be required for the field facilities and gas gathering system. Shell stated that TransAlta would expand its power transmission system in the area to adequately meet these power requirements. Shell added that this upgrade should also benefit commercial and residential users in the general area by increasing electric power reliability.

Water Requirements

Shell estimated that its overall raw water requirements would average 100 cubic metres per hour (m^3/h). To reduce raw water demands, Shell proposed to re-use treated waste water. Water generated in the SCOT process, runoff water, and treated sewage would be used as additional water sources. Fresh water from a network of shallow wells in the Red Deer River valley would make up the remaining project water requirements.

Water Disposal

Shell stated that water produced from the reservoir would be separated from the raw gas and hydrocarbon liquids at the compressor stations and would subsequently be injected into a deep disposal well at 3-30-34-4 W5M. All liquid effluent collected at the proposed gas plant which could not be treated and re-used would be injected into a deep disposal well at 6-29-34-5 W5M. Shell emphasized that no produced water, sewage effluent, process fluids, or liquid wastes would be released to the watershed from Site E from the proposed plant site.

2.3 Husky

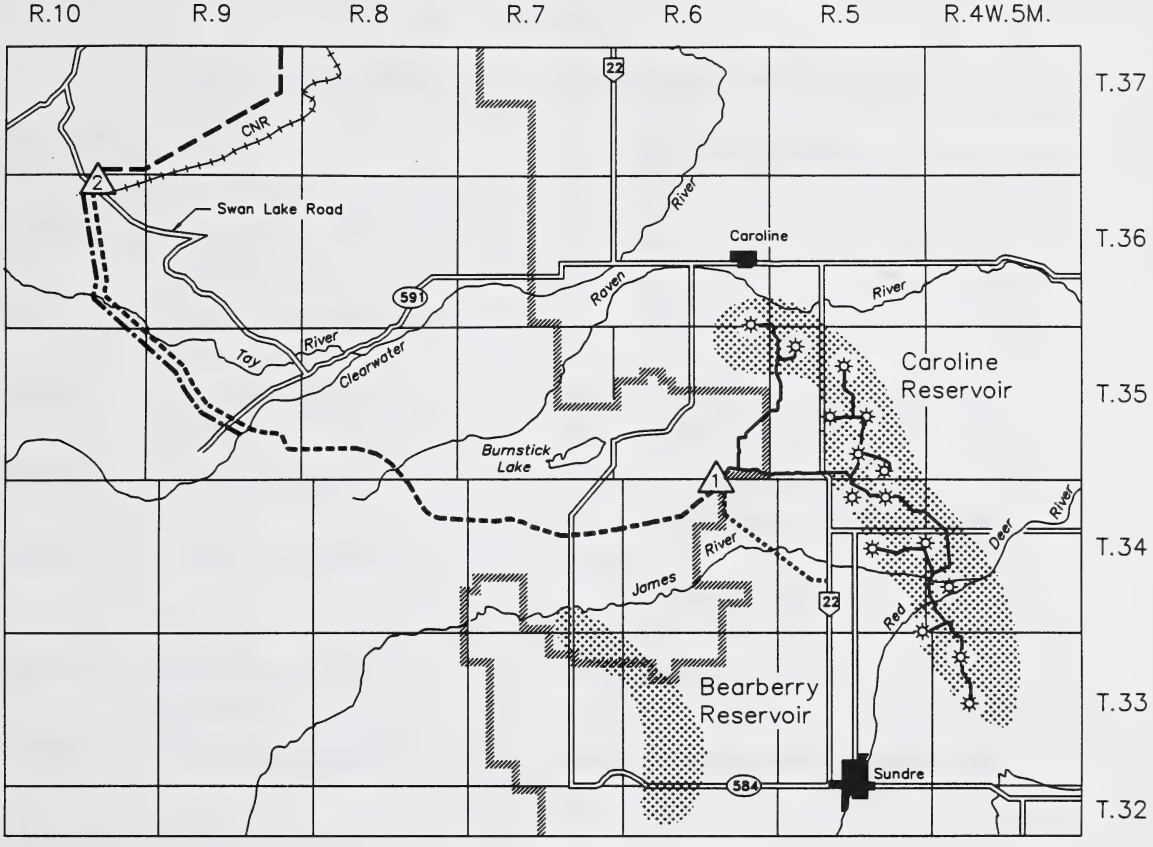
Husky submitted its applications on behalf of itself and its 100-per-cent-owned subsidiary, Canterra.

Husky's proposal is comprised of five individual applications filed by Husky and two associated applications which were filed by other applicants. The facilities relating to Husky's project are shown in **Figure 3** and the applications are listed in **Table 4**.

Husky's proposed facilities would be comprised of the following three main components:

- new Caroline gas transmission plant (Site E),
- sour gas transmission pipelines from Site E to Ram River, and
- an expanded Ram River gas plant.

Husky stated that it endorsed the Shell applications for the gas gathering and compression system which would be operated by Shell.



- Existing gas well
- Proposed Husky Caroline (Site E) gas transmission plant
- Existing Husky Ram River gas plant
- Proposed Husky gas transmission pipelines
- Proposed Shell gas gathering system
- Proposed Amoco condensate pipeline (connects to Rangeland system)
- Proposed Husky fresh water pipeline
- Proposed Federated natural gas liquid pipeline
- Alberta Green Area boundary

FIGURE 3 HUSKY DEVELOPMENT PROPOSAL
CAROLINE BEAVERHILL LAKE GAS RESERVOIR

TABLE 4

APPLICATIONS FOR HUSKY'S PROPOSED DEVELOPMENT

Application Number	Facility	Facility Location			
		Sec	Twp	Rge	Meridian
891047	Expansion of Ram River gas plant	35	36	10	W5
		and 2	37	10	W5
891757	Proposed gas transmission plant (Site E)	35	34	6	W5
891805	Sour gas transmission pipelines	from: proposed gas transmission plant			
		to: Ram River plant			
891804	Fuel gas pipeline	from: Ram River plant			
		to: proposed gas transmission plant			
891803	Fresh water pipeline	from: 15	35	9	W5
		(Clearwater River)			
		to: Ram River plant			
891703(1)	Natural gas liquids pipeline	from: Ram River plant			
		to: 17	47	27	W4
891802(2)	Condensate pipeline	from: proposed gas transmission plant			
		to: 8	34	5	W5

(1) Application submitted by Federated.
(2) Application submitted by Amoco.

2.3.1 Field Production Facilities

Husky did not make separate application for any of the field production and gathering facilities and stated it endorsed the Shell applications for the entire gathering and compression system. Husky added that if its processing project were approved, Shell's field facilities and gathering proposal would be operated by Shell but would be fully incorporated into Husky's development.

2.3.2 Gas Transmission Plant (Site E)

Husky stated it would construct a gas transmission plant in the NW 1/4 35-34-6 W5M which is at the terminus of Shell's proposed Caroline field gathering system and would be at the same location as Shell's proposed Caroline gas plant. At the hearing, Husky stated it would be prepared to consider other possible plant sites.

Husky applied for a maximum daily raw gas inlet rate, including Altana's acid gas, of 8915 x 10^3 m^3/d. At its proposed design rates, Husky's total Site E plant feedstock would include a maximum of 3127 x 10^3 m^3/d of H_2S (4239 t/d of sulphur equivalent).

Husky stated that under normal operating conditions no SO_2 would be continuously emitted from its proposed Site E plant. However, as some sour gas would likely have

to be flared during plant upsets, Husky proposed to install a 78-m emergency flare stack to ensure air quality objectives and compliance with Alberta Environment's Clean Air Act. Sour vapours would be collected and sent to the stack where they would be combusted and converted to SO_2.

Husky stated that its proposed Caroline transmission plant would be somewhat unique in that it would process the Caroline inlet feed and would separate and treat the hydrocarbon liquids to produce saleable (stabilized) condensate. All of the sour gas would be compressed and transported by the proposed transmission pipelines to an expanded Ram River gas plant for final processing.

Husky's proposed gas transmission plant would utilize raw inlet separation, stabilization, overheads-gas compression, main sour gas compression, and condensate product storage and shipping facilities. At maximum daily throughput rates, the plant would process a maximum of 2926 m^3/d of stabilized condensate. The condensate would enter two 4400-m^3 storage tanks on the plant site from which it would be pipelined to Amoco's Sundre Terminal at 8-34-5 W5M and on through the existing Rangeland system to market.

Husky stated it would install three 3700-kilowatt (kW) electrically driven sour gas compressors at Site E in order to move the sour gas to its Ram River gas plant for further processing. Husky stated the compression system would operate with two compressor units on line with a third on stand-by.

2.3.3 Transmission Pipeline System

Husky's proposed transmission pipeline system would consist of two 406.4-mm OD single-phase sour gas pipelines, 55 km in length. The lines would extend from Husky's proposed gas transmission plant at Site E to the Ram River gas plant, and would be installed in separate trenches within a single pipeline corridor. Husky stated the lines would be designed to meet or exceed Level 4 requirements as described in ERCB Interim Directive *ID 81-3*. Husky also proposed to install an 88.9-mm OD sweet fuel gas pipeline from its Ram River plant. It would extend the full length of the transmission pipelines to provide a fuel gas supply for the proposed 25 automated line block valves and three line heaters on each transmission pipeline, and for the gas transmission plant at Site E. Husky also applied to construct a 168.3-mm OD fresh water pipeline from the Clearwater River at section 15-35-9 W5M to the Ram River plant to provide additional cooling water for the expanded gas plant. One 406.4-mm OD sour gas pipeline would share a common trench with the sweet fuel gas pipeline for the full length of the route and the second sour gas pipeline would share a common trench with the fresh water pipeline north of the Clearwater River.

Husky proposed to equip its dual sour gas transmission lines with cross-over piping at each end of the pipeline and at each line block valve location. Husky stated that its proposed dual sour gas pipeline system would

- reduce the potential H_2S release volumes in the event of a pipeline leak or rupture,
- allow the system to continue operating at a reduced capacity when any single line segment was shut down for maintenance or repairs, and
- allow the circulation of line pack volumes above the hydrate temperature during supply or delivery interruptions. This could assist in eliminating the need to purge or flare line pack during certain shut-down conditions at either end of the pipeline.

To further minimize public risk associated with the transmission pipelines, Husky would utilize a comprehensive leak detection system to ensure early detection.

In addition to the new fuel gas pipeline, Husky stated it would also have a sweet fuel gas tap and meter station from the NOVA sales pipeline which is near Husky's proposed gas trans-mission plant. Husky stated that in the event that its sour gas transmission pipelines would have to be purged and shut in, the NOVA tie-in would supply sufficient volumes of sweet natural gas to purge the entire sour gas trans-mission pipeline to the Ram River plant and thereby reduce the need to flare in the Carol-ine field or at the Site E transmission plant.

2.3.4 Ram River Gas Plant Expansion

The tabulation at the bottom of this page shows the Husky Ram River plant's currently approved rate and applied-for rate to accommodate the Caroline gas. Husky stated that its Ram River plant is currently processing raw feedstock from 14 fields. The inlet gas from the different fields, which varies in H_2S content from 10 to 34 per cent, is pipelined to Ram River through a gathering network of about 600 km which extends through a large segment of the foothills region.

Husky said that during normal operating conditions, it expected the plant's average daily SO_2 emissions to be 27.2 t/d (13.6 t/d sulphur equivalent). Husky indicated that because of its proposed higher sulphur recovery efficiency, the existing 91.4 m high incinerator at Ram River would be adequate to ensure compliance with Alberta Environment's Clean Air Act requirements.

Husky stated it would have to carry out a number of modifications at the existing plant in order to process the Caroline reserves, including the following:

- retrofit the sulphur recovery facilities to increase their sulphur recovery capacity by using oxygen-enrichment,
- remove the two Sulfreen units which handle the Ram River plant's present tail gas,
- modify the existing piping and equipment used in the plant's water treatment facilities,
- improve the plant's pneumatic systems by installing new instrument and plant air systems,
- improve and augment the fuel gas supply system,
- install new high- and low-pressure steam facilities and, if necessary, a new power boiler,
- expand the gas leak detection system,
- expand the fire detection and water system,
- modify the SCADA system, and
- upgrade the groundwater monitoring system.

	Current Approved Rate	Proposed Rate
maximum daily raw gas inlet (10^3 m^3/d)	17 749	26 244
maximum daily H_2S inlet (10^3 m^3/d)	3 437	5 014
(t/d sulphur equivalent)	(4 660)	(6 800)
annual average sulphur recovery efficiency (per cent)	98.4	99.8
minimum quarterly sulphur recovery efficiency (per cent)	98.1	99.5
maximum daily SO_2 emissions rate (t/d)	177.0	68.0

Husky said it would also have to install new facilities at its Ram River plant, including the following:

- inlet separation,
- gas sweetening (Sulfinol) for H_2S and CO_2 removal,
- a molecular sieve gas dehydration unit,
- propane refrigeration and cryogenic refrigeration provided by turbo-expansion (deep-cut) for ethane plus recovery,
- ethane plus product pressurized storage facilities,
- residue gas compression,
- a new oxygen (air separation) plant for oxygen-enrichment,
- two new SCOT tail gas clean-up units,
- new plant inlet and outlet ESD valves,
- a new plant emergency depressuring system,
- a new 78-m flare stack to handle the Caroline gas flaring requirements, and
- a cryogenic flare system.

2.3.5 Sulphur Forming and Handling Facilities

Declining production from existing fields has resulted in under-utilization of Husky's present sulphur handling facilities at Ram River. Husky indicated that even with the increased sulphur production from the Caroline reserves, the combined sulphur production would not exceed the Ram River plant's existing design sulphur handling capacity of 7800 t/d. Husky maintained that no modifications or expansion would be required to its existing sulphur handling facilities.

Husky did indicate that it would have to upgrade its sulphur degassing facilities which currently degas the sulphur down to about 40 ppm of H_2S. With its proposed modifications, Husky said that the modified sulphur degassing system would ensure the sulphur was degassed to below 12 ppm.

Husky acknowledged that excessive sulphur dusting is presently occurring at Ram River which it said is primarily due to the design and operation of its sulphur priller. It stated that if its Caroline development proposal were approved, Husky would modify its sulphur forming facilities to ensure that sulphur dusting at Ram River would not increase above present levels. It indicated that even if its Caroline proposal were not approved it would still proceed with a sulphur dust abatement program. It is currently evaluating various mitigative measures and plans to develop a solution to the sulphur dusting problem before the end of 1990. Husky said it would investigate various options including possible introduction of new sulphur forming facilities, such as the Sandvik Rotoforming Process or others, to replace the priller.

Currently the sulphur product from Ram River is shipped in different forms, some as molten sulphur in tankers, some slated, and the balance prilled. To help minimize sulphur dust, Husky had reduced the volume of sulphur being prilled. Husky said that after the appropriate remedial measures are incorporated, it should be able to increase the priller throughput without creating incremental sulphur dust. (The matter of sulphur dust at Ram River is discussed further in Section 8.7).

Husky indicated that it was in the process of remelting the remaining portions of the existing sulphur block at Ram River. If proposed Caroline sulphur has to be poured to block, Husky would use a portion of the existing block. It added that it would take appropriate steps including designing a new base pad for future sulphur storage which would prevent any further groundwater contamination. (The matter of sulphur storage and groundwater contamination is discussed further in Section 8.4).

2.3.6 Hydrocarbon Product Pipelines

The Federated, Amoco, and NOVA product pipelines that would be required for Husky's project are described in Sections 2.4 and 2.5 of this report.

2.3.7 Altana Acid Gas

Husky indicated it had held discussions with Altana and an understanding was reached that if Husky's proposal were approved, appropriate applications for the necessary facilities would subsequently be filed so that Altana's currently flared acid gas would be processed at Husky's Ram River gas plant.

2.3.8 Infrastructure

Roads

Husky's proposed upgrading of roads in the Caroline field and specifically in the vicinity of its proposed Site E gas transmission plant would be similar to that planned by Shell except for Husky's additional upgrade of the Swan Lake road which would improve the south access road to the Ram River plant. Husky stated the improved access would help accommodate increased traffic to the Ram River plant during construction and allow easier access to the plant from the Sundre and Caroline areas.

Electric Power

Husky said that electrically driven compression units would be utilized at its Site E gas transmission plant. Husky added that the estimated 8.1 MW of power for the plant would be supplied by TransAlta in the same manner as it would for Shell's proposed plant.

Husky stated that an expanded Ram River plant, to accommodate the Caroline reserves, would require additional power. Husky estimated that an additional 5 MW of electric power would be required for the expanded processing facilities and 21 MW for its proposed oxygen plant. TransAlta would have to upgrade its current supply lines to Ram River along existing rights of way (ROW).

Water Requirements

Husky said that 0.5 m^3/h of water would be required at its proposed gas transmission plant for domestic, utility, and fire control use. This would be obtained from water wells it planned to drill in the area.

The expanded Ram River plant would require an upgraded cooling water system and an associated evaporative cooling water tower. Husky estimated that its maximum water requirements at Ram River would be 300 m^3/h, with half of this provided by water produced from the proposed SCOT units. To meet the peak demands, the remaining 150 m^3/h would be pipelined from water wells which Husky would locate in the flood plain of the Clearwater River, near the crossing of its proposed transmission pipelines.

Water Disposal

Husky said that any formation water produced from the Caroline reservoir would normally be removed at Shell's proposed field compressor stations. If there was produced water in the raw inlet streams at its proposed gas transmission plant, it would install a pressurized sour water collection system and sour water stripper at the plant. The produced water would be transported either by truck, or if volumes warranted, by pipeline to a disposal well in the area for deep well injection.

Husky stated it would construct a surface water retention pond at its proposed gas transmission plant site. It said the pond design would include a leak detection system to

minimize the potential for groundwater contamination. Husky indicated that it would not have to construct new runoff or water treatment ponds at Ram River as the existing ponds could accommodate the expanded plant. Condensed water from the SCOT units would be used as cooling tower water make-up.

Husky did not plan to expand its existing water disposal system at Ram River. Process and other waste water is presently injected into two disposal wells in the area and a third well near the plant is available if needed. Sewage from the expanded plant and administrative buildings would be handled through the existing septic fields. Husky plans to continue treating and releasing surface runoff water to the surrounding watershed with a total water disposal rate of 38.5 m^3/h for the expanded plant. (Surface water is discussed in further detail in Section 8.3 of this report.)

2.4 Other Related Applications

2.4.1 Federated

Federated applied to construct a 219.1-mm OD NGL pipeline from either Shell's proposed Caroline gas plant or from Husky's Ram River plant to its existing pipeline system at 12-17-47-27 W4M at a point near the Esso Bonnie Glen gas plant as shown in **Figure 4**. The Federated pipeline system would deliver the NGLs to storage and processing facilities located in the vicinity of Fort Saskatchewan or to various miscible-flood (oil recovery enhancement) projects. The Federated pipeline associated with the Shell project would be approximately 158 km in length while the one associated with the Husky project would be approximately 160 km in length. Of the total length, the northern portion of some 100 km is common to both projects. Both projects would require a pump station at the start of the pipeline and at the interconnection with the existing pipeline system. All landowners and occupants for both of the proposed Federated pipelines have given their approval to the proposed pipeline routes and confirmed that they have no objection to the Board issuing a permit to construct a pipeline. Federated said that each of its pipeline proposals is feasible, safe, and environmentally sound and that either could be constructed at approximately the same cost.

2.4.2 Amoco

Amoco applied to construct a 168.3-mm OD condensate pipeline from Site E to its existing Sundre Pipeline Terminal in 16-8-34-5 W5M (as shown in **Figures 2** and **3**). Except for a minor difference in the starting point within Site E, the pipeline would be identical for both projects and would be approximately 9 km long.

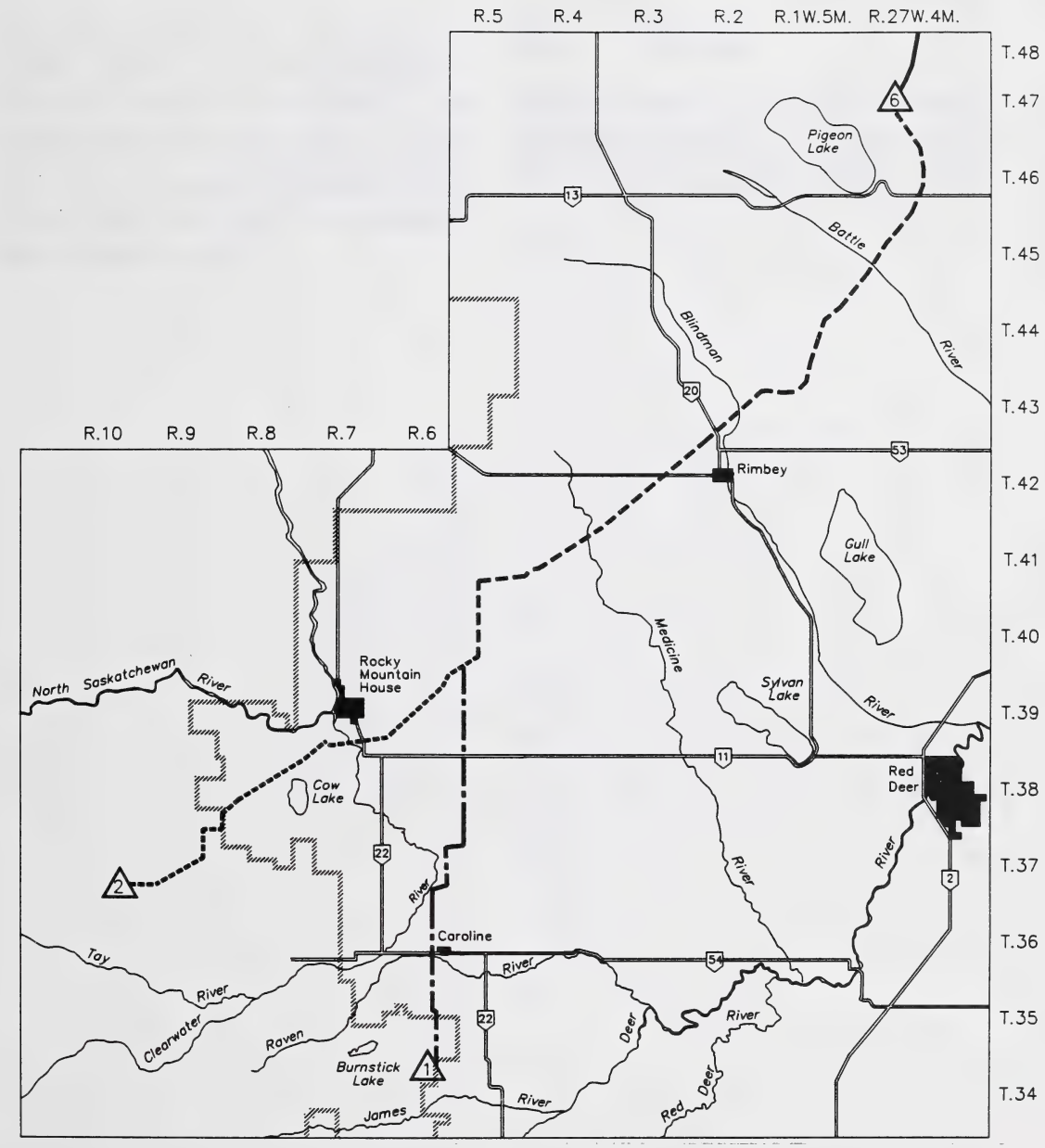
2.5 Related Future Applications

2.5.1 NOVA – Associated with Shell Project

NOVA meter station facilities would be required to accommodate the fuel gas needs during the construction phase and subsequently the sales gas production. Since Shell's proposed Caroline gas plant would be situated immediately adjacent to NOVA's gas transmission pipelines, only a very short sales lateral would be required.

2.5.2 NOVA – Associated with Husky Project

To accommodate the increased sales gas production from the expanded Ram River plant, NOVA's existing meter station serving the plant would have to be expanded. Approximately 16 km of 660-mm OD pipeline would need to be constructed immediately adjacent to NOVA's existing pipeline, from the Ram River plant to NOVA's existing gas transmission pipeline.



1 Proposed Shell Caroline (Site E) gas plant

2 Existing Husky Ram River gas plant

6 Existing Bonnie Glen facilities

Proposed pipeline

Proposed Caroline extension pipeline

Proposed Ram River extension pipeline

Existing pipeline to Edmonton area

Alberta Green Area boundary

FIGURE 4 FEDERATED APPLICATIONS
NATURAL GAS LIQUIDS PIPELINE

Without the Caroline gas, construction of a pipeline would be required although a 508-mm OD pipeline would be adequate. The Husky project would also require a NOVA meter station near Site E to provide fuel gas to purge Husky's proposed transmission pipeline to Ram River in the event of an emergency plant shut-down at Site E.

2.5.3 TransAlta

TransAlta would be required to submit applications for facilities to provide necessary electrical power for either project. (This matter is further discussed in Section 13.3.)

3 POSITIONS OF THE INTERVENERS

This section summarizes the position taken by various interveners respecting the Shell and Husky applications outlined in Section 2.

3.1 Altana

The Shell project includes a plan to have the acid gas from Altana's existing 12-36 gas plant moved to the proposed Shell plant for sulphur recovery.

Altana supported Shell's project because of its more favourable economics and Altana's strong preference for being an owner in a state-of-the-art gas plant. Altana expressed confidence in Shell's ability to operate the proposed plant and field facilities in an environmentally safe manner.

3.2 ATCOR

ATCOR appeared at the hearing in support of Shell but did not present direct evidence or final argument.

3.3 Gulf

Gulf appeared at the hearing to support Shell's development. Gulf stated it owns a 9.1 per cent interest in the Caroline gas reserves with a 2.4 per cent gross overriding royalty interest. Gulf said it performed a detailed economic assessment of both proposals and based on this evaluation it found Shell's project to be more economically favourable. Gulf also stated that Shell's proposal was the preferred option from the standpoint of co-ordinated area development, timing of that development, environmental and economic impacts, operator commitment, experience, and public health and safety.

3.4 Mobil

Mobil said it owns 2.5 per cent of the Caroline gas reserves and argued that the Owners' position is important and deserves to be weighed appropriately. Mobil stated it took a proactive approach in assessing both projects since it is an owner in the Caroline reservoir and in the Ram River gas plant, and also owns a 42.5 per cent interest in the Bearberry reservoir. After evaluating both proposals, Mobil concluded that Shell's project, which would have one operator for the plant and field, would be the optimum approach. Additionally, Mobil suggested that Bearberry would become commercial, and integration with Caroline would ensure more orderly development under Shell's proposal.

3.5 Numac

Numac indicated at the hearing that it owns a 2.6 per cent interest in the Caroline gas reservoir. Numac stated that following its examination of both proposals and recognizing that Shell would be utilizing state-of-the-art technology, it concluded that Shell's project was the safest, most reliable and efficient method of producing and processing the Caroline reserves.

3.6 Union Pacific

Union Pacific stated it owns a 6.72 per cent interest in the Caroline reserves and stressed that the position of the Owners must be given appropriate consideration by the Board. Union Pacific stated that it supported the Shell project for the following reasons:

- the proposal is technically superior and safer,
- it is specifically designed to process Caroline fluids,

- Shell is further ahead from an engineering standpoint,
- having one operator for the field and plant assures more orderly development,
- Shell is the largest Owner in the field,
- Bearberry synergy is designed into Shell's proposal,
- Shell has the support of all Owners, with one exception,
- Shell's proposal is economically superior,
- cost overruns would be less likely because Shell's project does not require integration of an old plant with a new one,
- Shell's proposal would give priority to Caroline gas,
- the new sulphur forming facilities would minimize sulphur dust,
- Shell's rail route to Vancouver is shorter, and
- Caroline Owners would not be exposed to the environmental liabilities that currently exist at Husky's Ram River plant.

3.7 Mountain View Land Holders Group

Mountain View appeared at the hearing and supported Shell's proposal. The group stated that since the local people would incur the risks arising from the wells and gathering system portion of the Caroline development, they should receive as much economic benefit as possible. They claimed Shell's project would provide more benefits which would include

- an increased tax base,
- more construction jobs,
- more permanent jobs,
- greater spinoff benefits, and
- more acceptable safety features.

The group made the following recommendations:

1. Scheduling of the trains hauling sulphur and worker shift changes should be established so that they do not coincide with school bus times.
2. The operator should pursue a program to advise high school students about work opportunities arising from the project and the training required to qualify for those jobs.

3.8 D. Saunders and 447 Area Residents

Mr. D. Saunders appeared at the hearing on behalf of himself and 447 Sundre and area residents who signed individual letters in support of Shell. They indicated in their letters that since they would be in the vicinity of the field facilities, and would be exposed to any potential risks, the economic benefits should also stay in the area. They also expressed a view that employment benefits and safety would be better ensured by Shell's proposal.

3.9 R. and R. Brown and H. McCormick

These three Caroline area residents and landowners, who were represented at the hearing by Mrs. R. Brown, supported the Shell proposal for the following reasons:

- the new technology and new equipment proposed by Shell would be better,
- the benefits from Shell's project would remain in the area of greatest risks, and
- the improved roads, as proposed by Shell, would reduce possible traffic hazards.

These residents said the support for Shell from Owners should also be given consideration.

They opposed Husky's proposal as it would interface new and existing equipment which would increase the potential for failure.

3.10 J. and B. Macklin

The Macklins, who live in the NE 1/4-17-33-4 W5M, indicated they would be affected by the Caroline sour gas development. They stated that Shell's proposal is best suited for the Caroline production for the following reasons:

- the plant would use the best up-to-date technology,
- shorter pipelines would minimize risk and disturbance to area residents,
- Altana's currently flared acid gas would be processed at Shell's Caroline plant where the sulphur would be recovered; therefore air quality around the Altana plant would improve,
- production from the Bearberry reservoir could be better accommodated at Shell's Caroline plant, thereby eliminating the need for an additional plant in the area, and
- Shell's proposal would create greater economic benefits which are required to offset long-term adverse effects associated with the field development.

The Macklins added that Shell, which discovered the reservoir and which has 89 per cent of the Owners' support, has always been sympathetic to the community needs and concerns.

Mr. Macklin said that during his more than 20-year association with oil and gas developments, neither he nor his family have experienced adverse effects to their health or to the health of their livestock. He believed that there would be no adverse effects on the agricultural community from Shell's proposal.

3.11 S. and L. Roth

The Roths, who live in the Eagle Valley area in the NW 1/4-33-33-4 W5M, supported Shell. They believe that a new gas plant using the latest technology is better than upgrading an older plant. The Roths said that Shell has a genuine concern for the safety and comfort of the local residents and it has made a real effort to keep residents regularly informed.

3.12 Village of Caroline

The Village of Caroline, which has a population of 387, is the closest community to the proposed Shell plant site. Mayor Chapman, who spoke on behalf of the Village, said his community would be directly affected by the proposed development. He stated that the community had thoroughly reviewed the Shell project and the Village strongly supported the Shell project for the following reasons:

- new technology is safer than mixing new and existing facilities,
- a new gas plant is safer and preferable to a long-distance pipeline transporting sour gas,
- Shell's project would distribute the benefits more fairly throughout the affected area communities, and
- Shell's gas plant design would ensure effective environmental performance.

The Village indicated that sulphur recovery at Husky's Ram River plant could be increased independently of the Caroline project.

3.13 Caroline Advisory Board

CAB, which is a municipally created committee, stated it was concerned with the Caroline gas field development and it endeavoured to provide public input into the development planning. CAB indicated it tried to remain neutral and communicated the relative advantages and disadvantages of both projects to the public. CAB said that it represented the majority of the local residents affected by the Caroline development and stressed that it spoke for the "silent majority". CAB stated that the success of its members in

the last municipal elections, and the lack of opposition for the re-appointment of the citizens at large who are active members, indicated that CAB enjoys the confidence of the majority of the local voters.

CAB stated that its fundamental principles in assessing the Caroline development proposals, in order of importance, were

- maintenance and commitment to maximum public health and safety, which includes impact on the environment,
- enhancement of local economic benefits, and
- co-ordinated development in the best interest of Caroline area communities, local residents, and resource companies.

With respect to public safety, CAB contended that the possible risks associated with various facilities in the project are in the following order of importance starting with the highest risk: wells, sour pipelines, compressors, plants, and product pipelines. CAB opposed lengthy sour gas transmission pipelines from the outset.

CAB stated that benefits must accrue to the people in the areas which bear the risks, but not at a cost to the environment. It added that the Shell project would provide more offsetting economic benefits to compensate for the risks and negative impacts of the field and gathering system. Those economic benefits would also be more fairly distributed throughout the region by Shell's proposal. Shell's use of best available technology would provide a more reliable and less environmentally damaging processing alternative. CAB stated that Shell's proposal best complies with CAB's fundamental principles and that it would be in the public interest to approve the Shell project.

CAB opposed the Husky project stating that the risk associated with the sour gas transmission pipelines is not necessary.

CAB said that the communities have been well informed about the projects and to ensure this would continue, CAB offered to participate in an overall umbrella group which could work in a co-ordinated approach with the successful applicant to help ensure that the project was implemented in an appropriate manner.

CAB recommended that any approval for the Caroline development should be subject to the following conditions:

1. Continue public involvement in implementation and operation of the project.
2. Provide for public input into the draft Emergency Procedures Manual.
3. Ensure that there are as many benefits as close to the field and gathering system as possible.
4. Assist the local communities in ensuring that proper community health and social service infrastructure is in place to accommodate the construction phase of the project.
5. Perform and continue all baseline studies.

CAB expressed support for the conditions recommended by RVC which would require a plan for evaluating social and environmental impacts of the project and comparing them to those discussed in the Environmental Impact Assessment (EIA) and Socio-Economic Impact Assessment (SEIA). It also supported the PALSS recommendations for conditions dealing with baseline studies and monitoring. CAB recommended that all monitoring results, remedial programs, plans, data, and comparisons should be filed with the ERCB and Alberta Environment and be made available to the public on request.

Should the Husky project be approved, CAB recommended the following further conditions, subject to consideration of the associated capital and operating costs:

1. Greater redundancy in the fractionating train at Husky's proposed Caroline gas transmission plant.
2. Shorter sour gas transmission pipeline sections utilizing the best block valve technology.
3. Rotoform sulphur forming facilities for all the sulphur recovered at Husky's Ram River gas plant.

Additionally, CAB supported the conditions proposed by RVC requiring the remediation of the groundwater and sulphur dust problems at Husky's Ram River plant site.

3.14 Town of Innisfail

Mayor Newman appeared on behalf of the Town and indicated support for Shell. She stated that Shell had made a good effort in keeping the community informed of its project. Mayor Newman said Shell's project would bring a greater positive socio-economic impact to the communities surrounding the Caroline field.

3.15 Town of Sundre

The Town, which is a community of 1789 persons, was represented by Mr. K. Guenther. The Town had requested each company to address the matters of economic, environmental, and social impacts on the community. After reviewing the respective responses, the Town Council unanimously voted in support of Shell's project. The Town Council advertised its position and believes that the lack of opposition to its decision was also indicative of the positive support of the community for the Shell project. Mr. Guenther said that the convoy, held in Sundre in May 1989, brought to light the extent and strength of industrial, business, and community support for the Shell project. He also stated that Shell's project would have the following main advantages over Husky's project:

- greater positive economic benefits to the local community, and
- a safer and more efficient development of the Caroline and Bearberry reserves.

The Town Council was satisfied with the information that Shell had provided to the community and claimed that a new standard had been set by Shell regarding the incorporation of public input into project planning.

The Town was sceptical about the thoroughness and the readiness of the Husky project and expressed concern that the Husky project could result in long delays in initiating and completing the development. Mr. Guenther said that the people of the Sundre community did not want further unnecessary project delays.

3.16 County of Mountain View No. 17

Mr. S. Vollmin appeared on behalf of the County, supporting Shell for the following reasons:

- Shell's project is the only project which meets the County's criteria,
- it addresses the economic concerns of the individuals who are living in the sour gas field and assures some economic advantages to those same individuals,
- a new modern plant would be constructed so that negative environmental impacts would be greatly reduced, and
- shorter pipelines increase the safety level; and control and safety of long pipelines is a concern.

He said that Shell's Site E proposal would be the best location for the new plant; however, if it were found to be unacceptable, the new

plant should be located alongside the Shell Bearberry demonstration plant.

Mr. Vollmin said that people living in a sour gas field must have a say in the proposed development and should gain the maximum possible monetary benefit, which should stay in the local area. The County indicated that Husky's project would take away economic benefits from the Caroline area.

3.17 Caroline and District Chamber of Commerce

Mr. R. Bancroft appeared on behalf of the Chamber, which supported the Shell project, stating that

- Shell exhibited a genuine interest in the safety and development of the community,
- the Shell project would promote more trade and economic growth in the Caroline community,
- a plant at Shell's proposed site would be far safer than pipelining the sour gas 55 km, and
- it could better accommodate production from the Bearberry reservoir.

The Chamber stated that since the Caroline area residents would be subjected to sour gas risks, they deserve the economic benefits. It also stated that the Caroline area has the infrastructure to handle the influx of people that would occur from the development.

3.18 Olds and District Chamber of Commerce

Mr. J. Smith appeared on behalf of the Chamber, which supported the Shell proposal for the following reasons:

- the Shell project would result in a more equitable distribution of economic benefits among the communities like Olds and also where the resource is being extracted,
- Shell had undertaken a more consultative and comprehensive planning approach,
- its project would ensure the orderly incorporation of the Bearberry reservoir, and
- Shell's proposal would more appropriately address environmental impacts and risk issues.

The Chamber claimed that Shell had developed a reputation as a good corporate citizen.

3.19 Sundre and District Chamber of Commerce

Mr. D. Dewinetz appeared on behalf of the Chamber, which supported the Shell project. He stated there would be greater potential for real growth, development, and economic benefits in the Sundre area during construction and operation of Shell's project.

The Chamber referred to the May 1989 convoy in which the business community of Sundre joined together to show support for Shell. The Chamber said that Shell has been an excellent corporate citizen, and its commitment to the environment is evident in Shell's voluntary reduction of emissions at its Burnt Timber processing plant. The Chamber claimed that benefits from the Husky proposal would be almost nil for Sundre and area. It indicated that pipelining sour gas over long distances would result in needless risks when there is a better alternative.

3.20 CP

CP, which supported the Shell project, stated that it was the successful bidder against competitors for the contract to transport the Caroline sulphur production to Vancouver for export. CP noted that its route to Vancouver would be some 1100 km long compared to approximately 1600 km for its competitor. It

stated that there were no circumstances under which CN's freight rate could compete with the rate CP had offered to Shell.

3.21 Diamond J. Industries Ltd.

Mr. J. Bandura, who represented Diamond J. Industries Ltd., expressed support of the Shell project. He noted that CAB represents a large number of people and that CAB supports the Shell project, and suggested the ERCB should consider the wishes of residents in the project area. He expressed concerns about Husky's job contracting practices and questioned Husky's financial viability.

3.22 Canadian Hunter

Canadian Hunter stated it does not have a working interest in the Caroline reserves, but appeared at the hearing to present its views regarding the Board's disposition of the applications. It had no preference regarding the two proposals, but claimed the applications were unique and the Board should refrain from setting general principles as part of its decision that may affect industry as a whole. It suggested that because of the nature, size, and high H_2S content of the Caroline reservoir, the decisions arising from these proceedings should not necessarily be applied to future more conventional gas plant applications.

3.23 NOVA

NOVA appeared at the hearing and filed a letter of intervention which provided information with respect to facilities that would be required for each proposal. NOVA expressed no preference for either project.

3.24 Burnstick Lake Cottage Owners' Association

BLCOA appeared at the hearing and stated its main concern was to maintain the pristine nature of the lake, the purity of the air, and the tranquillity of the environment. BLCOA said the Caroline reserves should be developed, but only if there is appropriate regard for both the public and the environment.

BLCOA retained International Management Associates Ltd. (IMA) to examine various aspects of both projects and make recommendations. IMA and BLCOA conducted joint reviews of each proposal with the respective proponents and examined the following issues:

- critical wildlife habitat loss,
- climatology and air quality,
- risk analysis and emergency response planning,
- impacts to water and aquatic fauna, and
- security concerns.

BLCOA stated that environmental impacts associated with either proposal must be dealt with by the Board so that, through avoidance or mitigation, there would be no net loss of use or value of the environmental attributes of the area, and the safety of local residents and their property would be protected.

BLCOA recommended the operator of the approved project be required to do the following:

1. Design and implement a 5-year regional biophysical monitoring program in conjunction with local organizations and government agencies.
2. Establish a full-time air quality monitoring station and program in the Burnstick Lake area.
3. Establish and include the Burnstick Lake Cottage Development in a secondary response plan which would consider wind direction as well as the potential for loss of life external to the primary response planning area.

4. Install two permanent first alert warning systems at the Burnstick Lake Cottage Development and the public campground which would give audible warnings of a hazard when the primary emergency response plan is enacted.
5. Implement a security measures program by retaining qualified security guards to visit the Burnstick Lake Campground and Cottage Development three times daily during construction of the Caroline facilities. The security program should be augmented with full-time evening surveillance between 20:00 and 02:00 hours during May to September. A public phone should be installed in the area of the subdivision boat launch and all phones should carry appropriate signage encouraging the reporting of suspicious, malicious, or inappropriate activities.
6. Design, fund, and implement a 5-year regional social impact study to monitor social change within the successful applicant's project area. The findings of this study should be reviewed on a yearly basis through a community-organized Operations Committee comprised of representatives from the petroleum industry, the ERCB, the municipal district, Alberta Environment, and affected community organizations.

3.25 The Alberta Fish and Game Association

Mr. I. Johannson, who appeared on behalf of the Association, claimed that every industry should assist in preserving the habitats of fish and wildlife so that these resources may be sustainable. To offset the potential damage in these areas from the Caroline development by either applicant, the Association wanted to ensure that a net gain in fisheries and wildlife habitat would occur. It also suggested that new access in the project area be kept to a minimum.

3.26 Rocky Mountain House and District Chamber of Commerce

The Chamber favoured the Husky proposal for the following reasons:

- the Husky project would support the existing economy in the Rocky Mountain House region,
- it would promote growth of the economy in the M.D. of Clearwater,
- the economic activity generated by workers at camps would be spread over a broader area, and
- the Caroline reservoir has created an opportunity for the Ram River plant, which is one of Alberta's largest SO_2 emitters, to make a substantial reduction in its emissions.

The Chamber accepted that there may be a higher risk with transporting sour gas via a 55-km pipeline for processing. However, it added that the difference would be small enough to be acceptable when considered with the environmental benefit of the Husky project.

The Chamber said that Husky has proven to be a good corporate citizen in the Rocky Mountain House region.

3.27 CN

CN, which presently transports sulphur from the Ram River gas plant to Vancouver, favoured Husky's project for the following reasons:

- the Ram River gas plant is currently not fully utilized,
- high utilization of those facilities would ensure the continued use of about 200 km of CN's existing rail line serving Husky's plant, and continuation of the current associated jobs,

- Husky's proposal would avoid the need for a large new gas plant and sulphur handling facilities, and
- there would be a reduction in SO_2 emissions in the Rocky Mountain House region.

CN stated that although its route to Vancouver was longer than the proposed CP line, the grades on its system were much lower and therefore the difference in fuel requirements for the two systems would be insignificant.

CN said that in the event the Board determined that Shell's project should be approved, the alternative of the liquid sulphur pipeline going to existing sulphur handling facilities at Ram River rather than to Shantz should be considered. CN indicated this option could result in the following benefits:

- cost savings of approximately $20 to $35 million depending on the extent of upgrading required at the Husky Ram River sulphur handling facilities, and
- full utilization of the Husky Ram River and CN sulphur forming, handling, and shipping facilities would be assured.

CN suggested that Shell's approval should contain a clause requiring a full assessment of this option. It added that if the detailed review showed the capital costs, environmental considerations, and employment benefits were superior in the Ram River option compared to the Shantz proposal, Shell should be required to construct its liquid sulphur pipeline from Site E to Ram River.

3.28 Town of Rocky Mountain House

The Town Council indicated that the Husky project has a number of advantages over the Shell project, including:

- greater benefits to all areas,
- long-term viability of an existing plant as well as creation of significant new employment and business opportunities throughout the region, not just Rocky Mountain House,
- environmental benefits,
- use of proven technology, and
- no major new facilities would be required.

3.29 Concerned Residents Action Group

CRAG appeared at the hearing on behalf of 43 families living in the vicinity of the gas plant sites proposed by Shell and Husky (Site E). CRAG retained a number of experts to review Shell's applications and to help identify areas for possible concern. The group's concerns, which were presented at the hearing by some local members and their experts, included plant proliferation, wildlife, noise, site selection, groundwater contamination, future development, emergency response planning, emissions, soil and vegetation, quality of life, health, and property values.

Both Shell's proposed plant and compressor station locations were evaluated and CRAG concluded that several alternative sites may be as appropriate as the proposed locations. It suggested that other locations farther away from wildlife habitat areas and from residents should have been considered. It also suggested that the Board and Shell should reconstitute a site selection panel, including local residents, to examine the data gathered to date and select more appropriate plant and compressor sites. (This matter is discussed further in Section 11.5.)

CRAG reviewed the surface water matter related to Site E in Shell's proposal and claimed that extensive grading would be required to ensure that contamination from runoff would not occur. CRAG indicated that runoff and its relation to wetlands is a complex matter and should be given further consideration along with the sensitivity of wetlands to runoff reduction, sulphate deposi-

tion, airborne and waterborne contaminants, and possible chemical and fuel spills.

CRAG also evaluated the surface waters in the general Caroline area and suggested there is abundant evidence that the quality of water in area streams and the life in those streams are already declining as a result of various developments. It disagreed with Shell's view that by implementing mitigative measures during construction of roads and pipelines there would be no significant impacts on wildlife or fisheries.

CRAG conducted a groundwater review of Site E and addressed the potential for groundwater contamination. It agreed with some of Shell's conclusions that a low permeability, thick clay layer underlies Shell's proposed plant process area. However, CRAG said there are topographic lows in the general plant area, and claimed that because of the possible thinning of the clay layer in those lows, the underlying gravel bed could act as a pathway for off-site migration should contaminants move downward through that potentially thin clay layer. CRAG suggested that additional test drilling in the topographic lows would be advantageous to obtain more data.

CRAG examined the effect of Shell's proposed plant on land values in the area and disagreed with Shell's suggestions that there would be no effect on property values in the vicinity of large sour gas facilities. CRAG claimed that recreational or residential property would be less attractive to potential buyers as a result of a large sour gas facility and suggested that one way of easing the impact would be to reduce the size of the facility.

CRAG's experts evaluated the wildlife section of Shell's EIA and said the matrix method which Shell used did not reflect the public's best interests. CRAG stated that environmental issues should not be dealt with using a matrix, as wildlife issues alone could have resulted in the selection of another plant site. CRAG's experts also commented on a perceived shortage of baseline wildlife data for the Shell proposal.

The group evaluated the transportation aspects of Shell's application and claimed there would be significant changes in traffic during and after construction of the proposed Shell facilities. CRAG said that increases of up to 1480 per cent in traffic could be expected.

CRAG made the following recommendations:

1. Husky's project should be approved.
2. Jointly with area residents, Husky should be required to determine if its proposed Caroline gas transmission plant could be relocated to the proposed central compressor station.
3. In regard to the compressor stations, CRAG stated that Shell be required to review the compressor station locations to determine whether there are superior locations for the compressors and, following such an analysis, submit the data to the Board for subsequent approval.

CRAG also stated it endorsed the recommendations put forward by Dr. Kostuch and PALSS.

3.30 The Preservation of Agriculture and Living Space Society

PALSS stated that it supports orderly development. To fully assess Shell's and Husky's applications, it retained experts (Norecol) to make a comparison of the two proposals. As a result of this review, PALSS and its experts expressed concerns which included

- the need for long-term health studies,
- sulphur forming and dusting,
- air and water quality,
- soil acidification,

- engineering reliability,
- plant proliferation,
- land use, wetlands,
- effects on agriculture and livestock,
- socio-economic impacts,
- traffic,
- aesthetics, and
- welfare of future generations.

The PALSS experts said that from an engineering standpoint, both proposals were sound. They determined that contamination of surface and groundwater by sewage and sedimentation of streams from construction of either project were unlikely. PALSS did not see any potential for negative impacts on surface waters from waste water ponds, nor risks to surface or groundwater from the disposal of produced or process waste water. PALSS concluded that the potential for impacts to soil and vegetation would be the same for either project. It said that Shell's proposed liquid sulphur pipeline would have a very low risk for a line break or spill and even if this were to occur, the consequences would be minimal.

Following its comparative review of the two projects, PALSS said it preferred the Husky proposal for the following reasons:

- it would have lower sulphur emissions,
- it would have fewer visual impacts, and
- traffic and noise would be less in the areas inhabited by the PALSS members,

PALSS recommended that the operator of the approved project be required to do the following:

1. Conduct future sampling programs to obtain data on heavy metal emissions.
2. Have proper baseline environmental studies respecting air, water, and soil conducted in the project area by third parties and the results be made public.
3. On-going monitoring be conducted as in 2. above,
4. A proper long-term health study be carried out to permit on-going monitoring of any health changes in the project area.
5. Should there be a community consultive process, such an organization should include broad-based interest groups including members of PALSS.

PALSS also stated that if the Husky project were approved, Husky must fulfil its commitment to mitigate its groundwater contamination and to modify or adopt better technology to reduce sulphur dusting at Ram River. However, if Shell's project were approved, it should have to adhere to its commitment not to utilize a railway in the Caroline/Sundre area to transport sulphur. Additionally, PALSS supported CN's recommendation to have Shell construct the proposed liquid sulphur pipeline to Ram River. PALSS stated this would eliminate the need for a new industrial development in the Shantz area.

3.31 L. and J. Bauman

The Baumans appeared at the hearing and raised general concerns which included the following:

- SO_2 emissions,
- the impact of heavy metals and other contaminants on the environment, human and animal health and crops,
- soil testing,
- sulphate deposition, and
- perceived falsities in the EIAs.

They indicated they favoured Husky's proposal.

3.32 J. and L. Brunner

The Brunners, who presently live in Calgary, also have a country residence in the SE 1/4-17-34-4 W5M. They said their dwelling is

within 2.0 km of a sour gas well, the proposed south compressor site, and the existing Amoco South Caroline gas plant. Mrs. J. Brunner said she has been diagnosed with lupus erythematosus and believes exposure to noxious fumes would increase her health risks. She stated that she is opposed to any development, but if one proposal is to be approved, she preferred Husky's option. Mrs. Brunner also requested that the south compressor be relocated. (This matter is dealt with in Section 11.5.) If an approval were granted, Mrs. Brunner said that certain preventative or mitigative measures should be taken to protect her safety and that of her family. Those measures include:

1. The incorporation of post-approval negotiations on compressor site selection.
2. An emissions monitoring program with a monitor on her property that would automatically sound an alarm at very low emission levels.
3. A second emissions monitor on her property which the family could read.
4. Emergency and safety equipment on her property.
5. Help and co-operation from the oil and gas industry to develop an effective antidote for the effects of sour gas.
6. Establish barriers to deflect sour gas emissions in case of an H_2S release or pipeline rupture.
7. Increased setback requirements from pipeline facilities and wells.
8. Consideration of a cap on emissions.

The Brunners also expressed a dislike for the phone system method of notification and personal visits by operators during emergencies because of the length of time involved to accomplish them.

3.33 D. and M. Harris

The Harris family lives in Calgary and also has a residence and property at SW 10-33-7 W5M, about 5.6 km southwest of the Bearberry gas pool. Mr. D. Harris expressed a number of concerns including the following:

- safety,
- quality of life,
- the well-being of the biota,
- traffic,
- property values,
- fair compensation, and
- retirement plans.

Mr. Harris, who has a honeybee operation, stated that honeybees are susceptible to many of the emissions associated with the oil and gas industry. As the Ram River plant is not in the vicinity of agricultural lands, he favoured Husky's proposal.

3.34 J. Hermann

Mr. J. Hermann, who owns land at SW 1/4-9-36-6 W5M, expressed concerns about sour gas flaring and SO_2 emissions which he said caused risks to humans and animals. He indicated there must be a balance between environmental quality and hydrocarbon production and said that although those balancing costs today would be great, future costs would be much more significant. Mr. Hermann suggested that the clean-up of existing plants prior to approving more new plants would be more in the public interest.

3.35 E. and B. Jans

Mr. and Mrs. Jans appeared at the hearing and requested that the submission of CRAG be considered representative of their general views. Their concerns included

- flaring,
- noise,
- plant proliferation, and
- emergency response planning and traffic.

They indicated support for Husky's project, and expressed confidence that the Board's

decision would be the fairest for the development of the Caroline reserves.

3.36 Dr. M. Kostuch and RVC

Dr. Kostuch filed an intervention and appeared at the hearing on behalf of herself and the RVC. She expressed concerns about current conditions and the proposed Caroline development, stating the following:

- there are significant emissions of sulphur from existing gas plants located along the Rocky Mountain foothills and the continuation of present patterns of sulphur deposition would result in extensive damage to the forest ecosystems in the region, and
- little scientific investigation has been done on the effects of sulphur deposition on these forest ecosystems.

Dr. Kostuch stated that she was not opposed to the development of the Caroline sour gas reserves provided the processing and development could be done with minimal impact to human and animal health and forest ecosystems.

Dr. Kostuch said that after considering both Shell's and Husky's applications, she concluded the critical difference between them was the amount of sulphur emissions that would likely occur from each respective project. She stated there was a need for an absolute reduction in the rates of sulphur deposition in the region, as in her opinion, the paramount environmental issue was sulphur deposition on a regional scale.

Dr. Kostuch said there is a lack of baseline data and "hard" scientific evidence to prove that the ecosystem in the region has been damaged or adversely affected by sulphur deposition. To assist her in this area, she retained Mr. T. Bouman whom she stated was a scientist experienced in assessing the damage to forest ecosystems created by sulphur deposition. Mr. Bouman reviewed the EIA for the two proposals. He claimed that current air quality modelling is not an adequate tool for determining potential for forest damage. He said that forest decline is readily visible in the vicinity and downwind of the Ram River plant. To support his claim he provided a slide presentation showing damaged trees. He also conducted a site visit to the area for the Board and interested parties to illustrate his concern. He acknowledged that damage to the root systems of the forest in the area can be expected and emphasized that the best method to combat this would be to reduce overall emissions.

Dr. Kostuch suggested that in order to prevent potential further damage, the application that offers the lowest overall rate of sulphur emission in the region should be approved. The emission rate comparison should include the sulphur from the gas currently being processed, the Caroline gas, and the Bearberry reserves. She also suggested that the successful applicant be required to commence scientific work at once to determine what is happening in the regional forests in terms of accumulated acidity and buffering capacity of ecosystems, and estimate what changes would occur if the levels of sulphur deposition continued.

If either application is approved, Dr. Kostuch recommended that the following conditions be attached:

1. A declining limit for SO_2 emissions in the issued permit in accordance with the anticipated decline in the available reservoirs. This would ensure that the issue of SO_2 emissions will be reviewed when and if there are applications to process new reserves at the Ram River gas plant.
2. The proponent be required to extend the data base for forest risk assessment.

3. The proponent be required to select sites and monitor rain and throughfall chemistry and other parameters.
4. The proponent be required to complete additional experiments on sensitivity of regional tree species to soil chemistry and on the effects of soil structure on soil chemistry.
5. A condition in the permit requiring that monitoring data, and remediation programs, and results be filed with the Board and Alberta Environment and be made available to the public upon request.
6. Approval of the foregoing programs by Alberta Environment following consultation with the public and interveners.
7. Consideration be given to monitoring ground-level ozone concentrations and further testing on the synergistic effects of ground-level ozone and SO_2.
8. The proponent be required to develop a plan to evaluate the social and environmental impacts of the project and audit the success of the EIA and SEIA in predicting, monitoring, and mitigating the impacts of the project. The evaluations and audits should be filed with the Board and Alberta Environment and be made available to the public upon request.

If Husky's application is approved, she recommended that the following additional conditions be attached:

1. Remediation of the groundwater problems at the Ram River plant site.
2. Remediation of sulphur dust problems at the Ram River plant site.

3.37 R. E. Wolf

Mr. R.E. Wolf said his family owns property in the Wildcat Hills area in the NW 1/4 28-27-5 W5M. He claimed there is no need for the production of the Caroline sulphur and gas at this time and said he was concerned about Shell's methods of operation. He said he endorsed the report of CRAG's experts which evaluated Shell's EIA, and argued that the Caroline development should be denied or delayed.

Mr. Wolf said there is a need for long-term baseline studies. He expressed a concern that there is no pollution tax to provide incentive to clean up and believes that all waste gas and liquid effluent should be disposed of into the Devonian Formation.

3.38 The Pollution Sub-Committee of the Public Advisory Committees– Environment Council of Alberta

The Pollution Sub-Committee was represented by Dr. P. Ramalingam who indicated the intervention concentrated on the environmental impacts of the respective applications. He said that SO_2 emissions are a significant issue and should be an important factor in the Board's consideration of the applications. He recommended that Husky's project be approved for the following reasons:

- expansion of its existing plant would result in a reduction of regional SO_2 emissions, and
- it is feasible to expand the Ram River gas plant, therefore there is no need for another gas plant.

He also recommended that the Board consider the implications of the CO_2 emissions from the Caroline development.

3.39 Other Interveners

The following parties submitted separate interventions in support of Shell, but did not appear at the hearing:

DEKALB
Home
Norcen
PanCanadian
G. E. Allison Construction Ltd.
Sundre Emergency Medical Society
Sundre General Hospital
A. Macklin

The following parties submitted separate interventions that did not support or oppose either applicant. Additionally they did not appear at the hearing:

A. Ludwig

MD of Clearwater No. 99

4 BASIS OF DECISION

4.1 Overall Approach

The Board is in the somewhat unusual situation of having before it competing applications for a major gas processing project. Each of the Shell and Husky proposals would involve the processing of all of the production from the Caroline Beaver Hill Lake gas reservoir and therefore are mutually exclusive. Additionally, although there is clearly a need for gas processing and related facilities to make the large Caroline reserves marketable, the Board received no evidence which would suggest that more than one project would be in the public interest. It follows that only one of the projects, as put forward, could or should proceed.

The Board considered a number of ways in which it could evaluate the competitive applications. For example, the Board could assess the overall acceptability of both applications from a public interest viewpoint and if they were both acceptable, indicate that it is prepared to approve either of them. The commitment of the gas reserves to one or another of the applicants, through normal business decisions, would then decide which of the projects should proceed. An alternative approach would be to assess the overall acceptability, and also to carry out a comparative analysis of the two projects. The proposal judged to be most in the public interest would be approved.

The Board must assess the acceptability of the projects in terms of the public interest and this appeared to be agreed to by all participants at the hearing. Shell took the position that if the project proposed by the majority of Owners was found to be in the public interest, that project should be approved over any competing proposal. Husky's position was that the Board should do a comparative analysis of the two projects and approve only that which is judged to be the best. Husky stated that the preference of the Owners should be considered but should not be pivotal in the decision.

The Board is satisfied that it should make a comparative assessment of the public interest aspects of the competing applications. In doing so, the Board recognizes that the factors that make up the public interest vary with the circumstances and are judgemental and the weight the Board attributes to many of the factors in its final decision has to be, in large part, qualitative in nature.

4.2 Public Interest Criteria

The Board has developed a list of criteria which it considers relevant to the public interest in this particular case. In doing so, it has had regard for the purposes section of the Oil and Gas Conservation Act (Act) under which the subject applications have been brought before the Board. That section reads in part:

"*4. The purposes of this Act are*

a) to effect the conservation, and to prevent the waste of, the oil and gas resources of Alberta;

b) to secure the observance of safe and efficient practices in the locating, spacing, drilling, equipping, completing, reworking, testing, operating and abandonment of wells and in operations for the production of oil and gas;

c) to provide for the economic, orderly and efficient development in the public interest of the oil and gas resources of Alberta;

d) to afford each owner the opportunity of obtaining his share of the production of oil or gas from any pool;

e) . . .

f) to control pollution above, at or below

the surface in the drilling of wells and in operations for the production of oil and gas and in other operations over which the Board has jurisdiction."

On the basis of the above quoted sections of the Act and the views expressed by participants in the hearing, the Board believes the following criteria would influence the overall public interest:

- economic efficiency,
- technical feasibility and operating reliability,
- resource conservation,
- environmental impacts,
- risk to public safety,
- socio-economic impacts,
- public acceptability,
- future resource development potential, and
- impact of related applications (necessary industrial infrastructure such as pipelines and electric transmission facilities).

The above factors are not listed in order of importance but in the sequence in which they will be dealt with in this report.

The Board recognizes that there is an inter-relationship and some overlap between most of the factors. For example, matters such as operating reliability may influence other criteria, particularly economics, environmental impacts, and risk to public safety. Nevertheless, the Board in this case considers each of the listed criteria to be sufficiently important that it will deal with each separately. In doing so, the Board has taken care to not double-weight the importance of the factors, as was cautioned against by some participants in the hearing.

4.3 Working Interest Owner Preference

There was much discussion at the hearing of the importance of Owner preference and the role it should play in determining which proposal should be approved. The Board believes that the preference of Owners is a factor which influences the overall public interest in several ways. For example, it contributes to orderly and efficient development.

In this particular case, the Shell proposal is put forward on behalf of the Owners of some 89 per cent of the Caroline reserves. It thus has a clear advantage, in this regard, when compared with the Husky proposal which represents the preferred development project for the Owners of only some 11 per cent of the reserves.

Notwithstanding the Board view that Owner preference is a factor which influences the public interest, the Board does not believe it is a dominant one. In a situation where competing applications are before the Board and one project is judged, in terms of public interest, to be clearly superior to the other, the Board would approve the best application, whether or not it is the one preferred by the majority of Owners. The Board would take this action because it believes its responsibilities to protect the public interest justify overruling the preference of the Owners where there is a clear public interest reason to do so.

5 ECONOMIC EFFICIENCY

5.1 Introduction

Economic efficiency, as used in this report, is a measure of the total economic benefits which would be generated by the proposed projects. The Board, on the basis of the information presented at the hearing, has made an estimate of the time of start-up and of the capital and operating costs for each project, along with the total revenue that would result. The differences between the revenue and costs of the projects have been appropriately discounted to show a total net present value and allow a comparison of economic efficiency. The relative economic efficiency of the two projects has been assessed by the Board because economic efficiency affects the total potential benefit of the project, for example in terms of taxes and royalties. Therefore, improved economic efficiency is in the public interest.

This section of the report deals with total costs and revenue for the proposed projects. (Socio-economic impacts and benefits are discussed in Section 10.)

5.2 Cost-benefit Analysis

Husky presented a cost-benefit analysis which included not only an assessment of revenue and expenditures, but also estimates of certain other less tangible costs and benefits, such as those associated with the emission of increased amounts of SO_2. Husky suggested that such a cost-benefit analysis would be a further useful tool for the Board to use to assess the relative merits of the proposals. Shell doubted the value that a cost-benefit analysis would provide, but did present its own version of such an analysis, generally using the format followed by Husky.

Although the Board acknowledges that a cost-benefit approach can be useful to screen certain public policy issues, it questions its real value in assisting the Board to reach a decision respecting the Shell and Husky applications. While the cost-benefit framework offers a quantitative result, the methodology is a subjective exercise. It incorporates a host of assumptions about project economics and values society may place on related factors. For example, the Board does not believe that selective environmental impacts or risks to public safety can be as readily expressed in financial terms as those related to project cash flows. Such calculations tend to involve long-term effects and are subject to a high level of uncertainty. Given those uncertainties, the Board believes the cost-benefit results would be inconclusive in this instance and accordingly it has decided not to use the analysis as presented at the hearing.

5.3 Timing

The economic efficiencies of the proposed projects would be affected by the dates at which they could be completed and placed in operation. As a result, during the hearing considerable attention was focused on the likely plant commissioning dates. Shell indicated that if it receives the required approvals by July 1990, construction of its proposed Caroline gas plant would start in the autumn of 1990 and it could be commissioned by December 1992. Shell stated that it is well advanced in its facilities engineering and design, and added that some 400 thousand man-hours of engineering work was done prior to filing its applications.

Husky indicated that although its engineering and facilities design work was not as advanced as Shell's, it expected to execute interim and

letter agreements with the other Caroline Owners in the months immediately following its project's approval, at which time it would then proceed with the detailed engineering work. Husky stated that, to date, some 30 thousand man-hours of engineering work has been put into its proposal. Husky suggested that if it received approvals in July 1990, plant design could commence in October 1990 with site construction commencing in the spring of 1991. Husky said its project could be commissioned early in the second quarter of 1993.

It is evident to the Board that Shell's planning and engineering is well advanced relative to the Husky proposal. The Board expects that any lag in engineering work would likely delay Husky's earliest start-up date beyond the date projected in its application. The Board notes that Husky would not resume detailed engineering until at least interim commercial arrangements have been put in place and the other Caroline Owners have agreed to join the Husky project. The Board estimates that, at best, it may be 3- to 6-months after approval before commercial arrangements would be in place so that design work could continue. There would likely be a further 3 to 6 month period before Husky's project design would reach Shell's current stage.

The Board also believes the integration of new equipment with the existing Ram River plant facilities could bring about unforeseen complications and make the construction phase longer than forecast by Husky.

Based on the foregoing, the Board concludes that it is highly unlikely the Husky project would be completed in the time frame indicated by Husky. It is the Board's view that the on-stream date for the Ram River plant expansion project would be at least 6 to 12 months later than for the Shell project.

5.4 Capital Costs

Capital cost estimates for both the Shell and Husky proposals were discussed extensively at the hearing. Shell estimated total capital expenditures of $825 million (1990$)[(5)] for its project, while Husky estimated a cost of $756.6 million for its proposal. Shell, through its consultant Delta, provided what it called a "comparable estimate" of costs of $886.7 million for Husky's project, which was significantly higher than Husky's estimate.

While Shell's estimate of $825 million for its proposal was accepted by both parties, the Husky project estimates were subject to long debate regarding their credibility and accuracy.

In light of the extensive engineering work done by Shell and the details provided in its submission, the Board believes that the Shell estimates of capital costs for its own project are reasonable and acceptable. The Board, however, is not able to accept the estimates put forward by Husky for all aspects of its project.

The Board does accept the Husky estimates, totalling some $446 million, for the field and gathering system, Husky's proposed gas transmission plant, sour gas transmission pipelines, oxygen plant, and infrastructure. It does so, even though it believes that the stage of engineering work is such that there is potential of higher costs in some of the estimates.

With respect to the remainder of Husky's estimates for modifications to the Ram River gas

(5) All costs referred to in this report are given in 1990 dollars.

plant and startup costs, the Board notes that the estimate totals some $310 million. The comparable estimate presented by Shell for the Husky proposal is some $444 million, a difference of $134 million or over 40 per cent.

Husky did not provide a detailed cost estimate of its plant components. While it is evident that fewer equipment costs would be necessary to expand the Ram River plant compared with the new plant proposed by Shell, the Board believes that the cost of retrofitting existing and installing new equipment at an expanded Ram River plant would likely offset at least a portion of the cost difference between the Husky and Shell proposal. Indeed, the Board is concerned that retrofitting costs can sometimes exceed the equivalent new plant costs because of matters such as custom building of the new equipment, unforeseen problems of fitting new equipment with old, and required future replacement of existing equipment. Retrofitting can also create start-up problems.

In making its estimate of the capital costs for retrofitting the Ram River plant, the Board had regard for the estimates by Husky and also those put forward by Delta on behalf of Shell. The Board concludes that the costs would likely be somewhere between the two estimates. In particular, the Board believes the costs for the gas treating facility, modified sulphur plant, SCOT units, and utilities were over-estimated by Delta. Although detailed comparable estimates were not available, the Board believes these facilities were under-estimated by Husky. Additionally, the Board believes that Husky has under-estimated its likely start-up costs.

After reviewing the above-referenced items, the Board believes that the Husky estimate for modifications to the Ram River plant is low by at least $50 million. This would mean the total cost of the Husky project would more likely be in the order of $800 to $810 million compared to $825 million for the Shell project. For its analysis, the Board has estimated that the Husky project capital costs would be some $805 million.

Recognizing the limited engineering work done by both Husky and Delta on cost estimates for the Ram River plant expansion, and the nature of major retrofitting projects, the Board also concludes that there is considerably greater uncertainty respecting the Husky project cost estimate than is the case for the Shell project.

5.5 Operating Costs

The operating costs provided in the Shell and Husky proposals were similar. The first year operating cost provided by Shell amounted to some $40 million. This cost would likely decline over the project's life as the variable portion of the operating cost declines because of lower throughput. The Husky estimated operating cost amounted to $38.8 million in the first year of full operation, and for the same reason is expected to decline over time.

The Board believes that Husky's operating costs are slightly under-estimated for factors such as power costs. For this reason the Board, for its analysis, used similar operating costs for both projects.

5.6 Conclusions Respecting Economic Efficiency

The Board has evaluated the Shell and Husky proposals and finds that both projects are commercially viable, and the present worth value of both projects is similar, with a slight advantage to Shell's project over Husky's.

For its analysis, the Board used on-stream dates of December 1992 for Shell and September 1993 for Husky, and capital cost

estimates of $825 million for Shell and $805 million for Husky. Similar operating costs were used for both projects.

The Board's analysis indicated that the Husky project would yield slightly over $3.5 billion in present value benefits, using an 8.0 per cent real discount rate, and a net benefit of almost $2.5 billion. The Shell project would provide for some $3.7 billion in present value benefits, and a net benefit of slightly over $2.5 billion.

Therefore, it would have a small advantage over Husky's proposal in terms of economic efficiency. That advantage is somewhat increased by the greater degree of uncertainty in the cost estimates and commissioning date for the Husky project.

6 TECHNICAL FEASIBILITY AND OPERATING RELIABILITY

6.1 Introduction

The Oil and Gas Conservation Act and Regulations require proponents of all new facilities or project expansions to demonstrate, in their applications, that a proposed project is technically feasible and would operate reliably. With respect to the two competing Caroline projects, certain hearing participants discussed technical feasibility and operating reliability as matters which could result in one proposal being considered superior to the other. For this reason, the Board believes it is appropriate for the purpose of this decision to comment on the applications with respect to technical feasibility and operating reliability, giving particular consideration to the potential for flaring of sour gas.

6.2 Technical Feasibility

6.2.1 Field Facilities

Shell filed formal applications for the field facilities and gathering system, including the three proposed field compressor stations. Husky stated it fully supported Shell's Caroline field and gathering system applications and was primarily proposing an alternative gas processing option to Shell's project. Although a few of the hearing participants suggested that alternative compressor station locations should be considered by the successful applicant, the Board notes that the majority of residents in the area of the proposed field facilities did not oppose or object to the gathering system and field compressor applications. (This matter is discussed further in Section 11 of this report.)

The Board has reviewed the equipment and design of the proposed wells, flow lines, and compressor stations and notes that these facilities would meet or exceed the Board's technical requirements. Each component would be sized and designed appropriately to ensure that the Caroline fluids could be safely delivered from the reservoir to the proposed Site E processing facilities on a continuous basis with minimal and infrequent flaring in the field. The Board also notes that field facilities of similar size and design have been operating successfully in various populated and unpopulated areas of the province for a considerable period of time.

Both proponents stated that in the event of an upset or equipment shut-down, their respective projects could use high-pressure sweet fuel gas to purge raw sour gas from the individual wells to the compressor stations and then on to the gas plants. In Shell's case, the purging would end at Site E. Husky stated it would also have the ability to purge its proposed sour gas transmission pipelines to its Ram River plant. Although the purging feature is technically feasible, there was a lack of detailed data presented at the hearing as to how each operator would accomplish the sweet fuel purging under various scenarios and whether sufficient purge gas volumes would be available. Both applicants also stated they would utilize various leak detection procedures at their facilities but neither provided a clear description of their proposed systems. Therefore, the Board will require that the successful applicant provide appropriate details about the sweet fuel gas purging system and its operation and the leak detection systems and procedures.

6.2.2 Gas Plants and Sulphur Recovery Levels

Both Shell and Husky propose to use generally the same processing technology, including Sulfinol gas sweetening to treat the Caroline feedstock, molecular sieve gas dehydration, hydrocarbon liquids recovery using a turbo-

expander, and Claus sulphur recovery units followed by two SCOT tail gas clean-up units for further sulphur recovery. Both Shell and Husky propose to use oxygen-enrichment in their sulphur recovery units. Husky would install this at the outset to provide capacity for Caroline gas, while Shell would install this later to provide capacity if Bearberry gas was found to be commercially viable.

Shell

Shell would initially install air-based Claus sulphur plants to recover up to 4500 t/d of inlet sulphur from the Caroline reservoir. When Bearberry commercial production occurs, Shell would install 70 per cent oxygen-enrichment to provide about 3500 t/d additional sulphur processing capacity. When questioned why it did not propose to use oxygen-enrichment at Caroline at the outset, Shell maintained that additional time was desirable to allow for further evaluation and development of oxygen-enrichment technology to minimize scale-up difficulties. Shell also stated that it would not be economically advantageous to incorporate oxygen-enrichment for only the Caroline reserves.

Although Shell was very confident that it could achieve 99.8 per cent annual average sulphur recovery after a suitable plant start-up period, it was reluctant to commit to a higher level as an approval requirement at the outset. Shell did, however, agree that the recovery level above initial requirements could be reviewed for possible upward revision after a suitable period of operating experience. Looking further in the future, Shell believed that it might ultimately be able to achieve a recovery level of 99.9 per cent as a result of converting to oxygen-enrichment technology, and recovering degassed sulphur vapours when the Bearberry production would be incorporated.

Husky

Husky's Ram River plant is currently approved to process and recover a maximum of 4660 t/d of inlet sulphur, but is presently processing an average of only about 2300 t/d because of the declining deliverability in the currently connected fields. To accommodate the additional 4500 t/d of inlet sulphur from the Caroline reserves, Husky would increase the plant's capacity to 6800 t/d by converting the existing sulphur recovery units from an air-based system to an oxygen-enriched operation using 39 per cent oxygen-enrichment. Further, Husky said that if Bearberry commercial production becomes viable, it could accommodate 3500 t/d of Bearberry sulphur as early as 1997 by going to 100 per cent oxygen-enrichment, and as a result of its predicted declining production from existing fields.

Husky committed to maintaining an overall annual average sulphur recovery level of 99.8 per cent and a minimum quarterly average of 99.5 per cent in accordance with the current provincial requirements. Husky declined to voluntarily commit to any level higher than the current requirements.

Shell questioned the likely operating reliability of Husky's Ram River proposal and argued that Husky would encounter difficulties in the conversion to and use of oxygen-enrichment at the existing Ram River plant. Shell stated that it had operated a 200-t/d commercial Claus oxygen-enrichment system at its Jumping Pound gas plant in late 1987. It argued that oxygen-enrichment technology is presently only proven to that rate but that Husky was proposing a manyfold scale-up. Shell said that with such a scale-up it doubted that a smooth plant start-up could be carried out. During normal operations, Husky's four Claus plants would be required to operate at about two-

thirds above their original design capacity. Shell suggested that long-term operation of the modified Husky sulphur recovery facilities could not continue at loads well above design rates without considerable downtime.

6.2.3 Conclusions Respecting Technical Feasibility

The Board is satisfied regarding the technical feasibility of the proposed field gathering facilities. It would, however, require greater details respecting the leak detection procedures and the sweet gas purge systems.

With respect to the technical feasibility of the two gas plants, the Board assessed a number of matters including oxygen-enrichment and attainment of the required sulphur recovery efficiency.

The Board believes the oxygen-enrichment proposed by Husky would be technically feasible, but its use on a very large scale at this time could cause some operational problems. The Board also believes that Husky's use of a large degree of oxygen-enrichment at this time may limit future expansion to accommodate other gas including the Bearberry reserves. In order to process other gas, Husky's plant would have to experience a sulphur inlet rate decline from existing fields and Husky would have to operate the Ram River plant's sulphur recovery facilities using 100 per cent oxygen-enrichment on a continuous basis.

During the hearing, both applicants indicated that the Caroline reserves should be processed at maximum load factors whenever possible. If the Ram River plant were fully loaded, Husky's sulphur recovery units, which were first installed in 1971, would have to continually operate at levels well above their original design rates. The Board is concerned that the high rates, combined with the need to continuously use oxygen to process the existing and Caroline reserves, may jeopardize plant operating reliability.

While the Board has concerns about possible difficulties with the oxygen-enrichment aspect of Husky's proposal, the Board recognizes that this technology has benefits of reduced fuel consumption and some incremental improvement in sulphur recovery. For these reasons, if the Shell gas plant were approved, Shell would be required to further review the feasibility of implementing oxygen-enrichment at its proposed Caroline plant at the outset of operations.

With respect to the technical feasibility of achieving an annual sulphur recovery level of 99.8 per cent for the Caroline gas, the Board believes that such an efficiency is attainable with Claus plants that incorporate SCOT tail gas clean up units, whether the Claus plants are new or existing. Either project should thus be able to attain such a recovery, although there may be additional operating complexities with the Husky proposal because of the immediate use of oxygen-enrichment and the loading of the Ram River plant. Further, the approval of either proposal would require that an annual average sulphur recovery of 99.8 per cent and a minimum quarterly average of 99.5 per cent be achieved. Also, a review of these recovery level requirements will be required after a suitable period of operating history.

In summary, the Board believes the two projects are technically feasible. However, because of the requirement for a high degree of oxygen-enrichment and continuous high throughput rates at Ram River, the Board believes the Husky project may experience greater start-up and operating problems. These could lead to additional costs, some downtime, and possible flaring, with attendant

environmental effects. The Board thus sees an advantage to the Shell project in terms of technical feasibility.

6.3 Operating Reliability

After a detailed analysis of all the exhibits and testimony, the Board believes both Husky's and Shell's proposals are acceptable, on their own merits, with respect to operating reliability. This is consistent with the previous section where the Board concludes that both projects would be technically feasible. The following analysis is primarily to compare whether or not one of the projects would have an advantage over the other in terms of operating reliability.

To undertake an appropriate comparison, the Board required a common basis on which the analysis could be conducted. Referencing the evidence and transcripts, in addition to its experience with existing facilities, the Board developed a series of probable failure and shut-down scenarios which were then condensed into four general categories and three sub-categories. The shut-down scenarios were a single well, a single field compressor, the complete gathering system, and a other facilities. This latter category was subdivided into the Site E plants, pipelines, and the Ram River plant.

Each of the scenarios was analysed to determine the likely frequency that a shut-down or failure may occur and the likely result, with emphasis on the potential for sour gas flaring. Differences, if any, between the projects were then established.

The Board does not expect any significant difference in the frequency of shut-down occurrences between the proposals, with the exception of shut-downs related to the Husky transmission pipelines and the Husky Ram River plant. This would cause a marginally higher frequency of shut-downs for the Husky proposal as it would involve a greater number of facilities.

In analysing the result of shut-downs, the most significant potential impact would be from sour gas flaring, particularly flaring which would occur in the Caroline area. The primary limiting factor in responding to shut-downs, for either project, would be the Caroline fluids hydrate temperature of 30°C. This hydrate point would restrict the amount of time available for an operator to appropriately manage an abnormal situation. Shell stated a maximum of 4 hours was available while Husky indicated that a shut-in of up to 6 hours could occur before hydrate control would be required. The Board accepts that the time would be limited and at maximum, would be only about 6 hours.

6.3.1 Field Facilities and Site E Gas Plants

Single Well Shut-down

The Board believes there is no real difference in the result of a single well shut-down between either proposal. The only potential for flaring sour gas at a well site would occur when either a flow line from the well to a compressor station was plugged by a hydrate which could not be removed by depressuring into the compressor station, or in the situation of a flow-line failure. In either case, flaring at the well site would be manually controlled and sufficient sweet fuel gas would be available for proper dilution by either operator. Such scenarios would be infrequent for either project and the results should not be serious.

Single Field Compressor Shut-down

Shell

The Board concurs with Shell that in the case of a single field compressor shut-down, Shell would be able to reduce the discharge pressure

of the remaining field compressors, reduce its Site E plant inlet pressure, and continue production and processing at a reduced rate because of the plant's dual train design. This would not require any sour gas flaring but may result in some small amounts of sweet gas flaring at Site E.

Husky

The Board accepts that, as proposed, Husky would have two alternative responses to this scenario which would enable production to continue. The first would be to lower pressures as described above in Shell's response. However, this would result in a lower discharge pressure from Husky's Site E compressors which would necessitate a reduction in the operating pressure of the transmission pipelines and the Ram River plant inlet pressure. Husky stated it had not examined whether sales specification gas could still be produced at Ram River with a reduction in pressure across the sweetening system. The Board believes that utilization of this option could result in some flaring of either sour gas or, more likely, off-specification sales gas at the Ram River plant.

The second Husky alternative, which was put forward by Shell, would be to isolate the segment of the gathering system that was shut down, because of a compressor shut-down, and depressure and flare that volume in the field at the affected compressor station, while maintaining full production from the balance of the gathering system. The Board believes this alternative may need to be used on some occasions. If used it would result in flaring of sour gas in the Caroline area rather than at Ram River.

Complete Gathering System Shut-down

The Board expects the same result from a complete gathering system shut-down as that described for the single field compressor shut-down. The second alternative available to Husky, depressuring the system and flaring the sour gas in the field, would not be acceptable in this situation as it would involve a larger volume of sour gas.

Processing Facility Shut-down (Site E)

Shell

The shut-down of the Shell plant at Site E would necessitate the depressuring and flaring of all sour gas within the gathering system and plant. Shell stated that such an incident would occur only if the entire TransAlta power supply system for the Caroline facilities plus all of Shell's proposed emergency power generation capabilities at Site E and at each compressor station failed simultaneously. The Board notes that in order to provide a reliable power network, Shell proposed to have TransAlta provide three independent 138-kV lines to Site E and separate radial feed lines to each compressor station. The Board also notes Shell's evidence that the likelihood of a total power outage at the proposed Caroline plant would be less than once in 5 years.

In the Board's opinion, this scenario would occur very infrequently, and if it did, the flaring would likely occur under controlled conditions at the plant site and the field compressor sites.

Husky

Husky stated it would be unable to continue production in this situation but would have the ability to by-pass its gas transmission plant at Site E and purge the sour gas from the wells into its sour gas transmission pipelines and through to Ram River for processing. The Board concurs, but expects that although this situation would not require any sour gas flaring in the Caroline area, it would likely result in some flaring of off-specification sales gas at Ram River.

6.3.2 Pipelines

The Board does not believe that operation of the Shell liquid sulphur pipeline in conjunction with the Shantz sulphur forming facilities would have any significant negative effect on the operating reliability of the Shell project. Similarly, potential problems with the related pipelines which would transport the Caroline NGL and condensate should not significantly affect the reliability of either project.

The Husky proposal would also involve sour gas transmission pipelines. However, the Board agrees with Husky that with dual pipelines in separate trenches, and with crossover lines at each line block valve site, a failure which would result in a stoppage of the flow of gas to Ram River would be unlikely and, if it occurred, would be of short duration. A transmission pipeline failure should not result in any sour gas flaring at Site E or Ram River.

6.3.3 Ram River Plant

The Board concurs with Husky that in the event of a shut-down of the Ram River plant, the Caroline gathering system gas could be displaced into the transmission pipelines and be recirculated. It is the Board's judgement that some flaring of sour gas would likely occur at Ram River in order for the transmission pipelines to accept all of the gathering system gas volume.

In addition to potential shut-down problems as noted above, the Board sees a potential for operating problems at the Ram River plant, particularly when compared to the Shell proposal, for the following reasons:

- Husky, unlike Shell, does not have experience with the use of SCOT technology,
- during start-up, the Ram River plant would have to carry out flow adjustments from up to 15 fields while the Shell plant would have inlet flow from only one field, and
- the Ram River plant would have a mix of new and used equipment, compared to all new equipment at Shell's plant, and would therefore be more likely to experience problems.

The Board would expect a new plant such as Shell's proposed facility to achieve a 99.8 per cent sulphur recovery level within the first 6 months of operation. In the case of the proposed plant expansion at Ram River, it is quite possible that Husky may not be able to consistently achieve such a recovery within the same time frame.

6.3.4 Conclusions Respecting Operating Reliability

In summary, the Board believes that both proposals would be acceptable in terms of operating reliability. Accordingly, the Board would not require additional redundancy in certain equipment at the Husky gas transmission plant as was suggested by CAB. In comparative terms, Shell would have an advantage in handling field compressor shut-downs whereas Husky would have an advantage in handling Site E plant shut-downs. However, Husky would also have to contend with possible Ram River plant failures. This, along with the potential problems associated with retrofitting the Ram River plant and the number of fields it would be serving, causes the Board to conclude that, with regard to operating reliability, Shell's proposal is somewhat better than Husky's.

The Board would require that if Husky is the successful proponent, its gas transmission plant design be reviewed to ensure it would be capable of maintaining the appropriate discharge pressure during field compressor shut-downs. This improvement would likely minimize or eliminate the potential for sour gas flaring in these situations.

7 RESOURCE CONSERVATION

7.1 Introduction

The Board believes that an important measure of orderly development is the degree of overall resource conservation achieved by a development. The aspects of resource conservation considered are ultimate reservoir recovery, field and plant energy consumption, and sulphur transport energy consumption. (The latter two aspects are also discussed in Section 8.2.2 with respect to CO_2 emissions.)

7.2 Reservoir Recovery

Husky suggested that its proposal, relative to the Shell proposal, would result in possibly 1 or 2 per cent more gas recovery from the Caroline reservoir because of improved economics. Shell did not expect any significant difference in ultimate recovery between the two projects.

The Board believes that processing Caroline production at the Ram River plant could result in some extension of the lives of reservoirs currently producing to that plant, by lowering operating costs per unit of throughput. (Section 12 includes a discussion of the potential for other new gas supplies.)

Ultimate recovery from the Caroline reservoir, and from the Bearberry reservoir if its production were to proceed on a commercial scale, would be determined largely by operating costs at the end of the lives of these two reservoirs. In this regard, the Board believes that the Shell project would have some advantages because of its proposed plant being closer to these fields.

On balance, the Board does not believe it is appropriate to attribute any advantage to either Shell or Husky regarding reservoir recovery.

7.3 Field and Plant Energy Consumption

Husky estimated that its incremental fuel gas consumption over present usage at Ram River, for gathering, transporting, and processing Caroline gas, would be 333 x 10^3 m^3/d, which is considerably less than Shell's estimated usage of 630 x 10^3 m^3/d. Husky claimed that this is due in large measure to its proposed use of oxygen-enrichment in its sulphur recovery facilities, which would result in the generation of additional process heat and in lesser volumes of inert gases being heated in the plant's incinerator. Husky's estimates showed that these fuel gas savings more than offset the energy required to produce the oxygen and to transport the Caroline gas from Site E to the Ram River plant. Overall, Husky's estimated total additional energy consumption, fuel gas and electric, is approximately two-thirds of Shell's.

The Board questions the large difference in estimated total energy consumption between the two proposals. It believes that a portion of the estimated difference may relate to improvements in efficiencies in the existing Ram River plant. Nevertheless, on the basis of the information available to the Board, there is a significant advantage to the Husky proposal. Due to the apparent large fuel saving with oxygen-enrichment, the Board would require Shell, if its proposal were approved, to carry out a further review of the energy efficiency, economics, and operational reliability of using oxygen-enrichment at the outset in the Caroline plant.

7.4 Sulphur Transportation

Shell stated that the transport distance of sulphur product from Shantz to Vancouver via CP would be 1168 km, as compared to 1624 km from Ram River to Vancouver via

CN under the Husky proposal. Shell contended that less energy would therefore be required for the CP route, although not necessarily in proportion to the difference in distances.

CN claimed that the longer distance of its route was offset by lower grades, to the extent that energy consumption would be within 1 or 2 per cent of the CP requirements. CN further suggested that if the proposed Shell plant were approved, there would be environmental and economic advantages to pipelining the liquid sulphur to the existing sulphur forming and loading facilities at the Ram River plant. CN recommended that the Board require an examination of this alternative.

In the Board's view, the evidence suggests that there may not be a significant difference between CN and CP fuel consumption and hence no clear advantage to either proposal. Regarding the suggestion that Shell's proposed Caroline liquid sulphur pipeline be routed to Ram River rather than to Shantz, the Board would not condition any Shell approval to require further assessment of the Ram River alternative, because the Shantz proposal was found to be acceptable and because CN's suggestion of the Ram River option was not strongly supported.

7.5 Conclusions Respecting Resource Conservation

The Board sees an advantage to the Husky project in having less overall energy consumption in plant operations, resulting from the use of oxygen-enrichment technology. The Board sees little difference between the projects in terms of ultimate reservoir recovery or sulphur transportation fuel.

8 ENVIRONMENTAL IMPACTS

8.1 Introduction

It has been clear since the discovery of the Caroline Beaverhill Lake gas reserves that the development of such a large and sulphur-rich gas reservoir must be conducted in a manner which would ensure that any impacts to the existing natural environment are mitigated (reduced) to the greatest extent possible. Furthermore, such a development should only proceed if the remaining (residual) negative impacts which cannot be mitigated are considered to be less than the offsetting economic and social benefits. The Board believes that if a proposed development is predicted to have significant residual negative environmental effects which cannot be effectively mitigated, then approval should be denied, since such a project would not be in the public interest.

The difficulty facing the Board in making this assessment is that a clear measure rarely exists regarding the acceptability of environmental impacts. For some impacts, such as atmospheric emis-sions, where there are existing environmental standards, an assessment of the relative accept-ability of a proposed development can be made on a quantitative basis. In other areas, for example, impacts on wildlife, such standards are not readily available.

The Board recognizes that Alberta Environment administers the EIA review process, and in that capacity makes decisions regarding the need and scope of that review, and also co-ordinates the analysis by other provincial government departments of the EIA. At the hearing, Alberta Environment asked that the Board specifically recognize the issue of gas plant emissions and their potential for regional impacts. Alberta Environment also stated that subsequent to the Board's decision, it would be in a position to consider the successful application with regard to the requirements of the Clean Air Act, Clean Water Act, Water Resources Act, and the Land Surface Conservation and Reclamation Act.

In making its assessment of the environmental acceptability of the two proposals, the Board has relied in part on the comments and questions raised by Alberta Environment respecting the EIAs submitted by the applicants. Additionally, both applicants and several interveners provided technical experts to respond to environmental questions. Finally, many of the interveners spoke directly to environmental matters. They provided the Board with further insight as to the value placed on protecting the natural environment, and as to the trade-offs between development and its associated economic benefits, and possible environmental changes which would be considered acceptable.

Both proponents made lengthy and detailed submissions on environmental matters. The primary biophysical issues which the Board has considered in this section are atmospheric emissions, surface and groundwater (quality and quantity), wildlife, fish, vegetation and soil. Other issues which impact more directly on the human environment, for example, public safety, noise and land use, have been addressed in Sections 9 and 10. However, the Board recognizes the intrinsic inter-relationship between human and environmental well-being and has endeavoured to fully address these issues throughout the report.

8.2 Atmospheric Emissions

There is little question that atmospheric emissions represent the largest potential source of regional impact from a sour gas development, especially if the development is large and has a relatively high H_2S content.

The impacts of any new development in the Caroline region cannot be assessed in isolation, since the area already contains a number of sour gas processing facilities. Therefore, it is important that incremental impacts on regional air quality be assessed.

In evaluating the impacts of atmospheric emissions on regional air quality, the Board has considered three main contaminant sources. These are SO_2, which results from the combustion (incineration) of the small amounts of H_2S which are not removed during processing of the gas and CO_2 and oxides of nitrogen (NO_x), both of which are produced during the combustion of fuels such as natural gas, diesel, and coal. The Board recognizes that there were concerns expressed regarding other possible contaminants such as heavy metals; however, no evidence was presented that these would create significant problems. Additionally, tests conducted at other sour gas plants in Alberta have not indicated that these other contaminants represent an environmental risk.

Fugitive emissions of H_2S, various mercaptans, and volatile hydrocarbons, which can be released from a number of sources in small, but odorous volumes, are addressed in Section 10.2.4. Impacts from localized emissions due to flaring and sulphur block fires are examined in Section 8.7.

8.2.1 Sulphur Dioxide (SO_2)

The Board has required for many years that, where sulphur inlet rates are sufficient to warrant, the plant operator must recover a set minimum amount of elemental sulphur, based on a percentage of the total sulphur inlet. As discussed in Section 6, the Board believes that 99.8 per cent recovery is achievable with the technology proposed by either applicant. The Board will require a 99.8 per cent annual average recovery with a minimum quarterly recovery of 99.5 per cent. The remaining 0.2 per cent of sulphur, which would not be recovered, would be incinerated at the plant and emitted to the atmosphere as gaseous SO_2. Therefore, even if the sulphur recovery levels are met, it is recognized that some SO_2 would be emitted into the atmosphere and would result in SO_2 levels in the ambient air.

Standards and Guidelines

Ambient SO_2 levels in the atmosphere are routinely monitored on a continuous basis at sulphur recovery plants in Alberta. Current Alberta maximum permissible ambient air levels for annual, daily, and hourly SO_2 concentrations are:

Annual	10	parts per billion (ppb) (0.01 ppm)
Daily	60	ppb (0.06 ppm)
Hourly	170	ppb (0.17 ppm)

These correspond to the strictest of three Federal standards. The 0.17-ppm 1-hour standard is enforced at tree-top level in forested areas and at ground level in open areas.

Static monitoring of sulphur deposition rates is also required by Alberta Environment. This is done using a network of exposure cylinders which the operator is required to maintain in the vicinity of the plant. The Alberta guideline for total sulphation exposure is 0.50 milligrams of sulphur trioxide (SO_3) equivalent per day per 100 square centimetres (mg/d/100 cm^2 of SO_3 equivalent). The guideline for H_2S exposure is 0.10 mg/d/100 cm^2 of SO_3 equivalent.

At the hearing it was pointed out that different types of exposure cylinders, which were not directly comparable, were being used in the Caroline region. The Board intends to review this matter with Alberta Environment.

As mentioned previously, the sulphur compounds emitted from the plant will be in

the form of gaseous SO_2. Once in the atmosphere, gaseous SO_2 can be oxidized into a sulphate SO_4^{-2} particulate. These compounds are removed from the atmosphere by wet and dry deposition mechanisms. Dry deposition involves the direct accumulation of these compounds on the surface of vegetation or soil, while with wet deposition, the compounds are first trapped in rain or snow.

Presently, no standards for acceptable levels of sulphate deposition have been established in Alberta. Research in this area is currently under way to establish either sulphate or effective total acidity targets and this was discussed by both applicants and the RVC. The Board is actively monitoring this research and will consider how to best apply the eventual results. In the interim, the Board believes that it can only regard as preliminary the target loading values which were discussed at the hearing. In the Board's view the specific targets should not be used to judge the acceptability of either proposal although the matter of sulphate deposition is important. The Board intends to continue to work with industry, the public, and the government to ensure that appropriate standards are adopted.

Existing Measured Regional Sulphur Levels

Both applicants used existing monitoring data from regional gas plants as a source of current area SO_2 levels and sulphur deposition rates. Additionally, the recent Acid Deposition Research Program (ADRP) provided a measure of regional sulphate deposition.

The regional SO_2 levels were generally within the current Alberta standards, with the exception of occasional exceedances of the hourly SO_2 standards at monitoring stations in the region.

Both applicants indicated that present regional sulphur deposition rates were well below current guidelines. The maximum values measured using static monitors were 0.16 and 0.008 mg/d/100 cm^2 of SO_3 equivalent for total sulphation and H_2S, respectively.

The ADRP estimated that sulphate deposition in the Caroline and Ram River region was 20 to 50 kilograms per hectare per year (kg/ha/yr) which includes a background of 10.8 kg/ha.

Predicted Regional Sulphur Levels

Both applicants made extensive use of computer models to estimate worst case SO_2 concentrations at various distances from their proposed facilities. The models take into account a number of factors including stack height and diameter, exit temperature and velocity, local terrain and vegetation, and regional meteorological conditions. Shell and Husky also made use of data from the existing SO_2 sources in the region to evaluate their modelling results.

The Board recognizes the need for and the importance of atmospheric modelling and believes that the models selected by the applicants provided indications of trends and gave reasonable estimates of maximums. The Board also accepts and understands their limitations. For this reason, any approval granted by the Board based on modelling predictions will require monitoring to determine actual measured SO_2 concentrations. If exceedances were to occur, further modifications to the plant design and/or operations would be necessary.

Both applicants provided historical data on regional sources of SO_2 and used them as a basis for modelling the anticipated impacts of the two proposals on regional SO_2 concentrations and sulphur deposition. The most up-to-date data was provided by Husky as follows:

	SO_2 Emissions (t/d) 1988
Husky Ram River	53.5
Gulf Strachan	12.2
Mobil Harmattan	5.6
Amoco South Caroline	1.8
Amoco North Caroline	1.8
Altana Caroline	4.1
Home Harmattan-Elkton	1.6

In its submission, Shell assumed that the actual 1987 emission levels at all plants including the Ram River plant would remain at current levels, with the exception of the Altana plant. The Altana plant would be reduced to zero, while the Shell Caroline plant would emit an additional 16.3 t/d of SO_2 to the regional airshed. In the Husky submission, the actual 1988 Ram River emission level of 53.5 t/d of SO_2 would be reduced to 27.2 t/d, although a slight upward revision of this number would be necessary if Altana's acid gas was processed at Ram River.

Neither applicant included the SO_2 emissions expected from the Shell Burnt Timber plant or existing or future foothills gas discoveries in their models. One of the interveners suggested that the likely emissions from some of these reserves should have been included. The Board agrees with Shell that the Burnt Timber gas plant would likely have no significant impact on the Caroline region because of levels of emissions and intervening distances. The Board would require additional assessments of any future regional reserves of either significant size or H_2S content before permitting them to be processed.

Both applicants presented results from modelling scenarios generated using the Alberta Environment model, STACKS2 to generate hourly SO_2 averages, and ADEPT to calculate annual SO_2 averages and annual sulphate equivalent deposition. Furthermore, both applicants, in part at the direction of Alberta Environment, provided the results of several other modelling approaches. These approaches provided further insight regarding the effect of certain topographical features and seasonal variations. The Board does not intend to comment on the relative merits of the various approaches used, but does acknowledge the extensive work done by both applicants. The Board also found the meteorological data base from Ram River to be valuable and will require the successful applicant, as suggested by BLCOA and others, to gather these types of data. Additionally, the Board found that the use of several modelling approaches provided a reasonable approximation of the range of error which could be associated with a particular modelling approach.

Although the models provided a range of predictions, the Board has been able to draw certain conclusions. First, none of the studies predicted any significant exceedances of current annual SO_2 standards. With respect to daily and hourly SO_2 standards, under the Shell proposal, some exceedances are predicted near the proposed Shell plant under extreme case conditions. A similar situation was predicted for various Husky scenarios. In the first case, the modelling also assumed that the Husky Ram River plant operated at its currently licensed maximum SO_2 emission rate of 177 t/d. At these levels, frequent exceedances of the current hourly and daily SO_2 guidelines are predicted to occur at several locations in the vicinity of the Ram River plant. The risk of such exceedances declined significantly using that plant's recent actual annual average SO_2 emission rate of 53.5 t/d but some exceedances were still predicted. Under the Husky proposal, because the annual average emission rate would be 27.2 t/d at Ram River, the predicted frequency of exceedances is even less. Therefore, in terms of maintaining regional SO_2 air quality

standards, Husky's proposal has an advantage over Shell's.

With respect to sulphate deposition, the Board notes that only for fully licensed conditions, the model predicts deposition rates greater than 50 kg/ha/yr in some limited locations. The Board also notes that current estimated deposition levels are in the range of 20 to 50 kg/ha/yr, and because of declining reserves of high sulphur content gas, will likely be further reduced under either scenario. Based on the predictions made by both applicants, the Board finds that either proposal would likely have an acceptable sulphate deposition level. The Husky proposal does, however, represent a reduction in regional sulphur emissions. The Board can only comment that it is concerned about regional deposition levels under any development scenario, and will continue to work with Alberta Environment in the development of regional depositional standards.

The potential advantage of the Husky proposal with respect to regional sulphur emissions is further demonstrated by estimating lifetime SO_2 emissions under various scenarios. Under the Shell proposal, a total of some 212 000 t of SO_2 would be emitted over the duration of the projects from the combined emissions of the proposed Shell Caroline and existing Husky Ram River gas plants. This compares to an emission level of about 115 000 t of SO_2 under the Husky proposal, or a difference of some 97 000 t. The actual environmental impact of such a reduction is unknown, but is likely to be positive.

Existing Ram River Plant Operations

Both CAB and Shell raised an issue regarding the complex terrain in the vicinity of the Ram River plant particularly in relation to Baseline Mountain. They argued that the complex local topography created a downwash which subsequently resulted in SO_2 exceedances at Baseline Mountain. A detailed meteorological explanation of the downwash and required "*mountain to plant*" distance was provided by Husky. While the Board accepts Husky's claim that the plant should be far enough away from Baseline Mountain that downwash would not typically occur, there still remains a past history of more exceedances at Baseline Mountain than elsewhere. Data indicates that since 1971 there has been a significant number of exceedances at Baseline Mountain. Husky contended that this is operationally created as opposed to being due to undesirable atmospheric conditions. The Board believes that if certain operational aspects are creating these exceedances, they must be addressed by Husky whether or not it receives approval respecting the Caroline gas.

Conclusions Respecting Sulphur Emissions

Under either proposal, the facilities processing the Caroline gas would achieve an annual average sulphur recovery level of 99.8 per cent, as prescribed by the sulphur recovery requirements. In terms of overall regional sulphur emissions, Husky's proposal has an advantage with respect to reducing expected exceedances of annual, daily, and hourly SO_2 concentration standards and also regarding lifetime emissions.

Whichever project proceeds, the Board expects that Alberta Environment will prescribe proper monitoring requirements. Detailed baseline studies and monitoring were requested by a number of participants, including CAB, PALSS, and RVC. These requests related not only to SO_2, but also to heavy metals, ozone, and other compounds. They also dealt with the amount of monitoring required and locations of monitoring stations. The Board agrees that special monitoring is necessary, intends to ensure that Alberta Environment is aware of all requests, and will work with the

department in that regard. In accordance with recommendations from several participants, monitoring results will be made public. (Further information regarding monitoring is included in Section 8.7.)

8.2.2 Carbon Dioxide (CO_2)

Shell estimated that its proposal for gathering and processing the Caroline reserves would release 3240 t/d of CO_2 to the atmosphere. Of this amount, 2130 t/d would be released at the plant site, made up of CO_2 emitted from gas-fired equipment including the sulphur plant tail gas incinerator and the CO_2 contained in the raw gas which is released during processing. Shell stated that fuel gas used at its plant, and therefore CO_2 emissions, would be reduced by maximizing the use of sulphur plant steam to power the steam turbine drivers and so reduce the utility boiler steam requirement. Shell also stated it would be using a fuel-efficient, forced draft incinerator at its plant.

Fuel gas combustion at field facilities such as line heaters would result in 120 t/d of CO_2 emissions throughout the field.

Shell estimated that electrical power used at the gas plant and field facilities and produced at coal-fired power plants in Alberta would generate an additional 990 t/d of CO_2. Shell suggested that its proposed rail transportation of sulphur product from the Shantz terminal to the west coast would result in less fuel consumption and therefore less CO_2 emissions than Husky's proposal because of the shorter distance involved.

Shell also stated that CO_2 produced at its proposed Caroline facilities could be recovered for use in an expansion of an existing CO_2-flood enhanced oil recovery (EOR) scheme at Harmattan. Shell noted, however, that a decision to expand the Harmattan EOR scheme would be based more on the economic and technical feasibility of the scheme than on possible environmental benefits of reducing CO_2 emissions.

Husky estimated that gathering and transporting the Caroline gas to its Ram River plant and processing it there would produce 3314 t/d of CO_2. Of this, 1306 t/d would be produced at Husky's Ram River plant, most of which would be CO_2 received at the plant in the Caroline raw gas and released during processing. Husky noted that its proposed sulphur plant retrofit using oxygen-enrichment technology would result in considerable fuel gas savings relative to Shell's proposal because of the smaller sulphur plant tail gas volume being incinerated and because of the increased sulphur plant steam. This would result in the amount of CO_2 produced from fuel gas combustion at Husky's plant being less than 20 per cent of the amount estimated by Shell for its proposed plant.

Husky stated that the Meteorological Controlled Emission System (MCES) on its incinerator stack results in incinerator fuel savings by reducing the stack-top temperature whenever atmospheric conditions are such that satisfactory plume dispersion would continue even with the reduced temperature. Additionally, Husky stated that waste heat would be recovered from all turbine compressor units to further reduce fuel gas consumption and therefore CO_2.

Husky indicated that fuel gas consumption at its proposed field facilities, including its Caroline gas transmission plant, would produce 418 t/d of CO_2. Husky estimated that its electrical power requirements for its expanded Ram River plant, field facilities, transmission plant at Site E, and the proposed air separation plant would result in the production of 1590 t/d of CO_2 at the source thermal power generating plant. With respect to the electrical power requirement of the air

separation plant, Husky noted that CO_2 emissions could be reduced by 238 t/d if the electricity was generated using gas turbines at its Ram River site.

Husky disputed Shell's claim that sulphur transportation from the Shantz terminal would be significantly more fuel efficient than Husky's proposed transportation from the Ram River plant. Husky stated that although Shell's proposed transportation would be over a shorter route, the difference in grades between Shell's route and Husky's is such that fuel consumption, and therefore CO_2 emissions, would not be significantly different. CN said the two routes would be within 2 per cent of each other.

Conclusions Respecting CO_2 Emissions

The Board has considered the information submitted by Shell and Husky regarding CO_2 emissions from their respective proposals. The Board concludes that, although the projects have differences in terms of distribution of the total amounts of CO_2 between field facilities, the processing plant sites, and electrical power generating stations, the total amount of CO_2 emissions from either project would be similar. The most significant difference between the two proposals would be due to Husky's reduced fuel gas consumption at its Ram River plant made possible by the oxygen-enrichment technology. This advantage in terms of CO_2 emissions is offset, however, by the increase in CO_2 emissions due to the electrical power requirement of Husky's air separation plant and gas transmission plant.

The Board is satisfied that both proposals contain reasonable design measures to limit CO_2 emissions, and are therefore acceptable in this regard. There is very little difference between the projects in terms of total emissions. The Board notes that a significant portion of the CO_2 that would be emitted by either scheme, some 35 per cent, is a function of the reservoir gas composition and is independent of energy conservation measures.

The Board recognizes the increasing concern about CO_2 emissions to the atmosphere and their possible relationship to global climatic change. Some interveners suggested that a carbon tax on CO_2 emitted to the atmosphere should be imposed to encourage energy conservation, and possibly the disposal of CO_2 to underground formations as an alternative to venting the gas to the atmosphere. The Board is aware that the Alberta Government is involved in studies on CO_2 issues and expects that such suggestions will be considered in developing a policy for the province.

The Board notes Shell's evidence that a possible use for Caroline CO_2 could result from expansion of the existing Harmattan EOR scheme. The Board agrees with Shell that while some environmental benefit could be derived, any decision to expand Shell's Harmattan scheme would need to be based largely on the technical and economic feasibility of that scheme itself.

8.2.3 Oxides of Nitrogen (NO_x)

Shell estimated that the total NO_x emission rate from its Caroline project would be 3 to 4 t/d. This would be emitted from gas-fired equipment such as heaters and flare pilots. Although the final design of its fired equipment has not yet been completed, Shell stated that it would be using low-NO_x burners and all stacks would be designed to comply with Alberta Environment's standards for ground-level NO_x concentrations. These standards are 0.03 ppm for an annual average, 0.11 ppm for a daily average, and 0.21 ppm for an hourly average.

Shell proposed to use electric drivers on its field compressors to eliminate NO_x emissions from that source. Shell's estimate included NO_x emitted at the source electric power generating station for the project's electrical requirements.

In response to questioning, Shell stated that it would not expect any increase in NO_x emissions if the Bearberry reserves were integrated with its Caroline project.

Husky estimated that its proposal to process Caroline gas would generate a total of 6.25 t/d of NO_x. Of this amount, 1.81 t/d would occur at the Ram River plant, 0.3 t/d would occur at the Site E gas transmission plant and transmission pipelines, and 4.14 t/d would occur at the site generating electrical power to meet the project's requirements. NO_x sources at Husky's plants and on the transmission system would include gas-fired boilers, re-boilers, and heaters.

The Board has reviewed Shell's and Husky's evidence respecting NO_x emissions and has concluded that Shell's proposal appears to have a slight advantage in terms of lower NO_x emissions. The Board is also of the view that both proposals would employ adequate measures to minimize NO_x emissions and would comply with Alberta Environment Clean Air standards.

8.3 Surface Water

There is an obvious interrelationship between surface water, dealt with in this section, and groundwater, dealt with in the next section. Notwithstanding that some degree of overlap results, the Board believes they are each important enough to be addressed separately.

Within each project study area, surface water quality data has been collected to characterize the surface water resources that may be affected. Water in the regional area can be characterized by:

- A high pH, except for muskeg areas.
- Adequate dissolved oxygen levels, except for muskeg areas.
- High calcium, magnesium, and bicarbonate levels.
- Low sulphate levels with the exception of natural sulphur springs and two small creeks which currently receive treated runoff water from the Ram River plant.
- Low total suspended solids except for high flow periods.

For the Shell Site E gas plant, a supply of fresh water would be required to augment the recycled water obtained from the processing, sewage treatment, and storm water volumes. This additional requirement would be supplied by new source water wells placed to withdraw water from the Red Deer River. The supplemental water required would average 100 m^3/h and range from 50 m^3/h to an expected maximum of 150 m^3/h. Based on existing stream flow in the Red Deer River, Shell concluded that sufficient water would be available at this withdrawal level to meet all other current user demands. Domestic water for the construction camps would be supplied by two wells which would tap the James River. The Shantz sulphur forming facilities would also require an average of 13 m^3/h for process cooling and would be drawn from the Harmattan reservoir which draws water from the Little Red Deer River during periods of high runoff. Shell has applied for the required permits and licences from Alberta Environment for these water withdrawal volumes.

Shell stated it would operate its proposed Site E plant as a Class B gas plant which, in accordance with Alberta Environment's regulations, would not permit the discharge of process water to a watercourse, groundwater, or the surrounding watershed. Shell

committed to avoid releasing any other fluids or effluents to surface water or the surrounding watershed area from either the Shantz facilities or the Caroline gas plant. Waste streams from the plant would be directed to deep disposal wells, although application for injection into these wells had not yet been filed by Shell. Sanitary waste water would be treated in an on-site facility and re-used, and Shell said that discharge to a surface water course would not be required under normal plant operations. Shell noted its proposed Site E plant would present a low risk of surface water contamination as there are no water bodies in the immediate vicinity.

With regard to the Husky proposal, five local groundwater wells currently supply water for industrial purposes at the Ram River plant. Husky estimated that an additional 50 m^3/d of water would be needed for domestic and utility use, which could be obtained from the existing wells. Under the expansion proposal, additional water supplies would be obtained from the Clearwater River and pipelined 21 km to the Ram River plant. The fresh water pipeline would provide a maximum of 150 m^3/h of water for process cooling, although Husky claimed that, on average, only 30 m^3/h of water may be required. Husky said water withdrawal permits have not been applied for at this time pending further field investigations.

At Husky's proposed Site E gas transmission plant, raw water would be required for domestic, fire control, and utility use and these volumes would be obtained from wells to be drilled at or near the facility. Husky estimated its water requirement to be 0.5 m^3/h on a continuous basis. Husky said it did not anticipate encountering any produced sour water at its Site E gas transmission plant until the field pressures declined substantially.

Husky stated that its expanded Ram River gas plant would be operated as a Class B facility under Alberta Environment's regulations, and thus no release of process water to a surface water body would be allowed. All process waste water and produced water would be disposed of by deep well injection. Husky said it would continue to release sewage to septic fields and the lagoon. Surface run off water would continue to be tested, treated, and released to Loadout and Flare Creeks.

Experts for Husky, Shell, and several interveners generally agreed that surface waters in the study area have good buffering capacity and no problems due to possible acidification from airborne emissions are anticipated.

During the hearing, evidence was presented regarding the impacts of the existing Ram River plant operations on local surface water quality. The sulphur dust problem at Ram River and the corrective liming program has resulted in increased levels of calcium and sulphate ions (Ca^{++} and SO_4^{-2}) in streams adjacent to the facility, though pH has remained unaffected. The release of treated runoff water is likely the greatest source of the elevated conductivity values which are also observed. The discharge of contaminated groundwater may also contribute to this situation. Husky stated it recognized these problems and they would be addressed. Husky also suggested that there would be no incremental impact due to the addition of the Caroline gas reserves to its Ram River plant. However, Shell claimed the existing environmental problems at Ram River are not fully defined and could be very difficult to address. Shell stated that it did not want to assume those potential mitigation costs in order to process its Caroline gas.

The Board believes that each applicant has the desire and capability to transport and process the Caroline gas reserves with minimum impact on the fresh water resources in the region. Neither proposal appears to present an

unacceptable risk in this regard, and no significant difference between the proposals is evident. The Board has concerns regarding the local creeks that are affected by the current Ram River operations and agrees with several interveners that regardless of the outcome of the Caroline development, the problem must be mitigated. The Board accepts Husky's commitment that the problems would be rectified. The Board will monitor the situation and, along with Alberta Environment, review alternative disposal options, including the use of deep well disposal for all waste waters, including surface run-off rather than surface release.

8.4 Groundwater

The Board places a high priority on ensuring groundwater quality is protected during the development of oil and gas resources. In assessing the relative merits of the two proposals, the Board took into account differences in the possible risk of future groundwater contamination at the proposed sites for the plants and other facilities, as well as the implications of any existing groundwater contamination.

With regard to the latter issue, concern was raised by some of the Caroline Owners as to their potential liability for the existing groundwater contamination at Husky's Ram River plant site. The Board notes that groundwater contamination has occurred at Ram River from two sources, a condensate leak in the late 1970s and sulphur block run-off, both of which were identified by Husky in its application. The Board also notes that during the hearing, Husky made a commitment to resolve these problems whether or not Caroline gas is processed at the Ram River plant. Notwithstanding the commitment, the Board believes that the existing groundwater contamination at the Ram River plant would likely complicate the necessary commercial arrangements between Owners and the current plant owners if the Caroline gas should be processed at Ram River.

Shell indicated at the hearing that groundwater contamination has occurred at Mobil's Harmattan gas plant, and Shell's proposed Shantz sulphur forming facilities would be adjacent to Mobil's plant. Therefore, the Board must address the issue of possible incremental groundwater impacts arising from the development of either proposal.

Groundwater contamination could occur from several sources including the spillage of process fluids and liquid hydrocarbon product, leakage from ponds used to temporarily hold contaminated water, runoff from sulphur block storage areas, and from sulphur dusting.

In both proposals, condensate would be removed at Site E and pipelined to Amoco's Sundre terminal. The Board is satisfied that a key criterion used by both firms in selecting Site E was its relative suitability to contain any spills, including condensate. The Board also accepts both Shell's and Husky's plans to continue to monitor and ensure that no groundwater contamination from waste water storage ponds at Site E would occur. Therefore, no significant differences between the two proposals appear to exist on these issues.

With regard to sulphur storage, significant differences do exist between the two projects. Husky's proposal, which would have a maximum sulphur inlet rate of 6800 t/d, has the potential to increase the sulphur storage area at the Ram River plant site. Unlike Site E, the Ram River plant site has less native ability to prevent further groundwater contamination and has a relatively complex groundwater regime. Therefore, some increased risk of added groundwater contamination from sulphur block runoff appears to exist at this site. This risk is further compounded to an unknown degree by

the existing groundwater problems, and by the on-going problems with sulphur dusting from Husky's sulphur forming facilities.

In Shell's case, any storage of sulphur would occur at Shantz, where hydrogeological investigations are as yet incomplete. Early indications suggest that, from a groundwater perspective, stringent controls regarding base pad design including impervious barriers in the sulphur storage and handling areas would be a necessary mitigative measure. The Board believes that sulphur handling facilities can be developed, through proper engineering and design, in such a way as to ensure there is little risk to groundwater. Shell has committed to only pour sulphur to block on an emergency basis, to pave sulphur handling areas, to line with impervious materials any sulphur storage facilities, and to use other Shell sulphur storage facilities throughout Alberta, if necess-ary, to ensure that use of solid sulphur storage at Shantz is minimized. Furthermore, the low dust production levels from the proposed Shell Rotoforming facility should have little, if any, impact on the groundwater at Shantz.

In summary, the Board believes that with regard to groundwater issues, the Shell proposal has an advantage. However, the Board also notes that local hydrogeology at Shantz has not yet been thoroughly assessed by Shell and that the site is much closer to active domestic water wells than the Ram River plant. Therefore if the Shell project were approved, significant additional site investigation and stringent mitigative measures would be required to ensure that local groundwater contamination would not occur at Shantz.

8.5 Wildlife

A development the size of the Caroline gas reservoir has the potential to adversely affect a significant amount of wildlife habitat, regardless of which configuration is adopted for transporting and processing the gas reserves. Therefore, the degree to which wildlife species in the project area may be affected has been considered by the Board as one component of its evaluation of the two proposals.

Shell stated its project area has not been studied in depth with respect to wildlife populations, but by avoiding critical wildlife habitat and implementing extensive mitigation measures, potential impacts on wildlife would be decreased significantly. Shell committed to an overall net increase in wildlife habitat and to monitoring the effectiveness of the habitat enhancement measures that would be put in place, but did not provide details on how this would be achieved.

Shell stated that the Site E gas plant would occupy 60 ha of high-quality moose habitat. The liquid sulphur pipeline to Shantz would disturb another 9 ha of excellent moose habitat and would cross three areas of key wildlife habitat at the riparian (river bank) areas of the James, Red Deer, and Little Red Deer Rivers. This key wildlife habitat would be altered to the width of the pipeline ROW. Reclamation pro-grams would be designed to ensure revegeta-tion of these areas primarily to grasses, and for some wildlife species this would result in an increase in forage quantity and quality.

Husky would also locate its proposed gas transmission plant at Site E, but its smaller site would only disturb approximately 10 ha of high quality moose habitat. A further 123 ha of forested land of variable wildlife quality would be disturbed during construction of Husky's sour gas transmission pipelines. Approximately 30 per cent of this would be through relatively undisturbed areas, while the remainder would parallel existing linear developments. Along the length of ROW,

about 4.5 ha of critical wildlife protection zones would be altered, and some key wildlife habitat would be disturbed. Husky stated that construction and operation of its proposed pipelines is acceptable through these zones with appropriate reclamation, maintenance, and control of public access. It suggested that enhancement of existing habitat could be performed in areas off the immediate pipeline ROW. Husky said it is willing to work with local wildlife officials to attain a "*no net loss of habitat*" policy, but also provided limited information on how this policy would be achieved.

CRAG's experts supported the proponents' view that comprehensive baseline data for wildlife in the region was lacking. Although this criticism was directed primarily to the Shell proposal, the Board believes that several of the points raised could be equally directed towards the Husky proposal. The Board agrees that regional wildlife population and movement information is not readily available in published literature but recognizes the applicants' efforts to compensate by analysing habitat information. The Board accepts this alternative approach but believes that long-term baseline studies of wildlife species should be initiated as soon as possible, as part of the impact audit and mitigation process. CRAG's wildlife expert said he could not comment on the relative merits of the two proposals since he was not asked to study the impact of the Husky project.

In mitigating their respective wildlife impacts, both applicants committed to a "*no net loss of habitat*" policy. This was in keeping with recommendations from several interveners, including the Fish and Game Association. While the Board considers this to be a worthwhile objective, it questions how such a goal would be reached. For example, the creation of habitat with early successional stages of vegetation cover, such as grasses, may be beneficial to some wildlife species, but for others dependent on more mature or later successional habitat types, restoration of its habitat is intrinsically more difficult. Furthermore, neither company was able to indicate how its policy would address the issue of fragmentation of existing habitat by linear developments and other clearing. This is an issue of increasing concern to the Board, and one which the Board expects the industry to address in future.

The Board is confident that either applicant would work with the appropriate government agencies to reduce the impacts on wildlife species and habitat. The Board would require that the "*no net loss*" policy committed to by both applicants be adhered to in all aspects by the successful applicant. It would also require the successful applicant to evaluate and report on the success it has realized in implementing the policy.

In terms of actual wildlife habitat disturbed, the Shell proposal appears to have a slight advantage. The disturbance of land by Shell would include a significant amount of land already disturbed by agricultural development as compared to the relatively pristine forested areas that would be crossed by Husky's transmission pipelines. However, this advantage is reduced by the relatively larger amount of habitat area required by the Shell gas plant site, since this portion would not be available to wildlife over the life of the project.

A second key aspect of the impact of the proposed developments on wildlife is the increased access that would be created. A number of hearing participants referred to this problem and the likelihood of increased legal and illegal hunting, and the Board agrees that efforts must be made to properly control access. Both applicants cited certain mitigative measures which would screen the ROW access points from the public view or

restrict travel on the ROWs. Locations where access could be gained would be kept to a minimum. There remains some doubt as to the overall effectiveness of such proposals, particularly on Crown land or in previously undisturbed areas. The Shell proposal appears to have a slight advantage over Husky's, insofar as more of its facilities would be on private land where access would potentially be more easily controlled.

In terms of overall impact on wildlife, the Board believes that either project would be acceptable, but that special efforts and co-ordination with government departments will be necessary to accomplish the "*no net loss of habitat*" commitments made at the hearing. The Board does see a slight advantage for the Shell project in that less forested area would be disturbed and, if necessary, control of access would be easier to achieve.

8.6 Fish

The components of each project most likely to affect fish and fish habitat are the gas gathering lines, sour gas transmission pipelines and the liquid sulphur pipeline, and both proposals would involve stream crossings. The Board considers the potential for direct impacts to fish to include over-harvesting due to increased access, physical damage to fish habitat during in-stream construction, and inadequate restoration of riparian areas.

The issue of over-harvesting due to increased public access along pipeline ROWs into previously remote areas was raised during the hearing. Both applicants committed to making ROW access points difficult to enter and to see, and said that further site-specific precautions would be implemented during the operations phase.

Shell's gathering system and liquid sulphur pipeline would traverse primarily private lands. Therefore, it is possible that public travel would be restricted by landowners along these lines. No such control is possible on the Crown lands through which the Husky transmission pipelines would be constructed. The presence of Husky's construction camps at Ram River and Ricinus may also place short-term fishing pressure on relatively remote area streams. The need by Husky to develop new access points along the proposed transmission pipelines to service the ESD valves represents a further long-term risk for increased access and associated over-harvesting.

Also of significance to protecting fish and fish habitat is the number of stream crossings and the manner in which construction and reclamation would be carried out at each crossing. The Shell liquid sulphur pipeline from Site E to Shantz would involve crossing three relatively substantial rivers. It appears that none of the crossings should present major technical difficulties, but detailed engineering designs were not provided in the Shell applications or at the hearing.

Husky's sour gas transmission pipelines would require eight stream crossings, but of these only the Clearwater River appears to be comparatively broad, with braided channels. Husky was able to provide somewhat more information on the technical components of its proposed crossings than did Shell. Both applicants have agreed to work with Alberta Fish and Wildlife to mitigate the impacts of their project activity, and to enhance other fish habitat, resulting in a net habitat gain. Neither proponent indicated how habitat enhancement would be accomplished.

Evidence provided by CRAG suggested that along with the number of crossings, other features such as stream gradient should be considered in assessing relative impacts. The Board concurs with this, and notes that in general the crossings required by Husky would be less difficult than Shell's.

The Board believes that pipeline construction across flowing streams in the area could be accomplished with minimal disturbance to fish habitat and no major long-term effects. Either project is therefore acceptable, although the Board recognizes that a detailed program of stream reclamation and inspection would be required. Further, the Board would require the successful applicant to honour its commitment to "*no net loss*" of fish habitat, and to provide evidence of the eventual success of its program.

Overall, Shell may have slightly more indirect control over increased public access to streams and has fewer crossings. Husky appears to have fewer difficult crossings and to date, has produced a more detailed evaluation of them. Recognizing the extensive experience of the two applicants in managing pipeline construction, neither proposal has a clear advantage over the other in this area of concern.

8.7 Vegetation

The Caroline hearing involved extensive discussion of the atmospheric emissions involved for each proposal. Each applicant presented considerable evidence to support its emission predictions, and the Board's evaluation of the scenarios is discussed in Section 8.2.

The proposals of both Husky and Shell acknowledge that there are already significant, albeit declining, SO_2 emissions from existing sour gas processing plants in the broad region, and that development of the Caroline reserves would, without remedial work at existing plants, add to that total SO_2 load.

The specific issue of vegetation damage from atmospheric emissions was raised primarily by the intervention of the RVC. The intervention, though ultimately indicating support for the Husky proposal, presented testimony by its expert, Mr. Bouman, who stated that damage to forest vegetation was already evident in the vicinity of the existing Ram River plant. RVC claimed that a general deterioration of the local forests around the Ram River plant site was observable over the last few years, and this decline would continue given the types of emissions and chemistry of the soil in the forest areas adjacent to the Ram River gas plant. The RVC stated that the Board should use the opportunity presented by development of the Caroline gas reservoir to reduce regional SO_2 emissions by approving Husky's project.

Shell provided no direct evidence on the issue of regional vegetation damage other than to note that its proposal would reduce local sulphur deposition by recovering the sulphur from Altana's currently flared acid gas. Shell added its sulphur handling program would produce a minimal amount of sulphur dust and therefore would have no associated impacts on vegetation.

To refute the RVC claims that the forest was already being harmed by gas plant emissions, Husky provided its own soil and vegetation monitoring data collected in the area of its Ram River gas plant. Husky also referenced Forestry Canada studies that it believes support its conclusion that past and current levels of SO_2 emissions have had little or no measurable effect on regional soils and vegetation, other than in those areas under the direct influence of sulphur dust.

Husky acknowledged that sulphur dust and SO_2 fumigation during sulphur block fires have had an extensive negative effect on forest vegetation immediately adjacent to the Ram River plant. The area of detectable sulphur dust accumulation around the Ram River facilities is about 1700 ha and death of vegetation in the immediate plant vicinity has

occurred due directly to either dust or SO_2 fumigations during sulphur block fires. Soil liming programs in highly contaminated areas have been used to reduce the effect of elemental sulphur on vegetation and soil. Under the Husky proposal, it appears likely that significant sulphur dusting will continue, and possibly that the life of the sulphur block, and therefore risk of sulphur block fires, would be extended by the increase of sulphur throughput at the plant.

Husky does not believe forest damage is evident beyond the sulphur dusted areas from any gas plant emission related cause. For example, Husky noted that since 1971 it had commissioned a bio-monitoring program in the region through the use of pollution sensitive lichens. Except for some changes in the lichen population, attributed again to sulphur dust problems, species numbers and frequency data indicated that no acute or chronic damage to vegetation has occurred. Husky maintained that it did not expect any future damage to vegetation would occur since emission rates, under its Ram River plant expansion proposal, would be much lower than past levels.

At Husky's request, Forestry Canada also provided evidence to support the claim that no regional forest damage from SO_2 emissions is evident. Forestry Canada scientists stated that their research in the Ram River plant area indicated no obvious effect on trees from gas plant emissions. Their study did suggest that some trees in the region were under stress from a number of factors including disease and climatic effects, due in part to the relatively old age of some stands, and this has resulted in visible tree damage and death. Other, younger stands not influenced by external activities such as road building, were in good condition. Forestry Canada emphasized that adequate knowledge of the ecology of a suspect area is required, as well as information on climatic conditions, soil nutrient deficiencies, and insect and disease disorders in the area, in order to distinguish between the many sources of vegetation damage.

Mr. Bouman, on behalf of RVC, explained his concept of the biochemical reactions occurring in the soil and vegetation, and he also presented visual evidence of tree damage purported to be due to SO_2 emissions. Based on his observations, he prepared a report describing several stands of coniferous trees that had allegedly been damaged or stressed by atmospheric emissions. The RVC submission discounted Husky's bio-monitoring data, claiming that the surviving lichen species are SO_2 resistant. The RVC claimed that the situation is deteriorating in regard to forest vitality.

The RVC stated that the Board should act cautiously and rely on Mr. Bouman's evidence which it claims demonstrates that vegetation damage is already being caused by SO_2 emissions. The RVC indicated that if Caroline reserves are to be developed in the overall public interest, it must be done in an environmentally sound manner. In its view, this would make the Husky proposal more favourable.

The RVC suggested that approval of either project should be granted subject to a number of conditions which are listed in Section 3.36. The Board has indicated, in Section 8.2.1, that emissions and related impact monitoring in the area are important and that it will work with Alberta Environment to ensure an appropriate program is designed and implemented. The Board is not willing to condition its decision with the monitoring suggestions of the RVC, but will consider them during the design of the monitoring program.

Regarding the matter of SO_2 emissions, the Board is not prepared to adopt a declining

level condition as suggested by RVC. The Board considers the forest and soil impact possibilities raised by RVC as serious, but cannot see substantive evidence to support the concern. The Board notes that the extensive long-term studies by federal scientists concluded no material detrimental effects beyond the immediate area of the Ram River plant. The Board and Alberta Environment have the jurisdiction to review matters if in future negative effects from regional emissions are shown to be occurring.

Consistent with the discussion of regional plant emissions for each proposal, assuming no independent reductions at the Ram River plant, the Board sees the Husky proposal as having an advantage in reducing total regional SO_2 emissions. However, the Board notes that if the RVC concern about possible forest vegetation damage is correct, approval of the Ram River plant to process the Caroline gas reserves would result in no net SO_2 reductions in the area of this plant. The Board believes this would tend to offset the Husky advantage relative to vegetation and reduced SO_2 emissions and, as a result, sees little difference between the projects in terms of impact on vegetation.

8.8 Soil

The Caroline development proposals may have two forms of impact on local soil conditions. The first is loss of soil materials due to improper handling and storage, which could impact on eventual reclamation success particularly along the required pipeline ROWs. The second is a deterioration of site and surrounding soils due to contamination by spills or sulphur dusting. (Impacts to regional soils due to sulphate deposition are dealt with in Sections 8.2.1 and 8.7.)

8.8.1 Soil Conservation

All of the regulated pipelines associated with each proposal require the submission of a Development and Reclamation (D&R) Plan which addresses, among other things, the soil conditions along the pipeline route and the actions required to mitigate the effects of disturbance on soils. Some potential negative impacts that pipeline construction may have on soils include

- loss of topsoil due to erosion,
- mixing of topsoil and subsoil horizons,
- redistribution of soluble salts and calcareous materials, and
- soil compaction.

The proposed Shell D&R Plan examines the gathering system, the liquid sulphur and water pipelines, and the NGL (Federated) products line. The Husky draft D&R Plan includes the sour gas transmission pipelines, the water pipelines, and the NGL (Federated) products line. The Board is of the view that either proposal would be acceptable in terms of pipeline soil conservation and protection, and no significant difference exists between the proposals.

Unlike regulated pipelines, the remaining proposed facilities do not require a D&R Plan. The extensive hydrogeological studies of Site E by Shell have provided a good data base on existing soil conditions which would be applicable to either proposal. Since the Husky gas transmission plant site would be significantly smaller, proper soil removal and conservation should be somewhat less difficult for Husky than for Shell, which would favour the Husky project. Shell had less data for conditions at its proposed Shantz sulphur handling facilities but did commit to continuing a detailed investigation of both the soil and hydrogeology at that location. Husky did not comment on soil conservation for its expanded Ram River site.

8.8.2 Soil Contamination

At Shell's proposed Site E gas plant, measures to protect the soil (and groundwater) from contamination would include a combination of

synthetic and natural clay liners on all areas used to store contaminated liquids. Shell said the possibility of on-site spills of deleterious chemicals was low and would not likely affect large areas. Liners or paving would also be used around the potential sulphur block pad area at Shantz. Sulphur dusting levels at the Shantz facility were predicted to be very low.

Husky has had a soil monitoring program for several years in the vicinity of its Ram River plant. This study is aimed primarily at delineating the surface area contaminated by sulphur dust. Husky reported that to date, roughly 1700 ha have been affected to various degrees. It has carried out a soil liming program in order to neutralize the potential for localized soil acidification. In addition to sulphur dust, Husky reported an on-site condensate spill. This spill has been dealt with to some extent, but reclamation efforts will likely continue for some time.

During the hearing, Husky committed to employing whatever technology was required as a result of expansion, to maintain sulphur dusting at no more than current levels, but was unable to confirm the technology which would be used. This committment was in part a response to the recommendation from a number of interveners, including the RVC and PALSS, that mitigation of any of the sulphur dust problems should be stipulated in any Husky approval. CAB recommended that Husky's approval be further conditioned to require Rotoform sulphur forming facilities at Ram River. The Board will require that the sulphur dusting problems be rectified, but will not, at this time, stipulate a particular means. (The impacts of sulphur dusting at the Husky plant are also discussed in Sections 8.3, 8.4, and 8.7.)

8.8.3 Conclusions Respecting Soil

The Board is confident that with appropriate measures for soil conservation, pipeline and facility construction by either applicant could take place with minimum impact. Construction practices have improved over those of the past and the Board recognizes the efforts that industry has made to achieve better topsoil salvage and protection. The Shell proposal would require development of a larger plant site at Site E. However, this disadvantage is offset by Husky's need to expand the Ram River site and to develop the relatively large sour gas transmission pipelines. The Board sees each applicant's potential for achieving the necessary soil protection and conservation objectives as being approximately equal.

With regard to soil contamination, the Board notes that while Husky has committed to not exceed current levels of sulphur dust production at Ram River, extensive soil contamination has already occurred and could continue in the future. Since the Shell sulphur forming process would produce less sulphur dust, the Board views this as an advantage for the Shell development.

8.9 Conclusions Respecting Environmental Impacts

As indicated in the introduction to this section, there are several biophysical issues which the Board has considered in assessing the environmental aspects of the proposals before it. On the basis of its considerations, the Board has concluded that either of the projects could proceed without serious long-term or unacceptable effects on the environment. However, in order to accomplish this, care will be required in the design and operation of all facilities. Additionally, on-going effective monitoring will be necessary, and prompt actions will have to be taken when monitoring results indicate problems.

Dr. Kostuch, supported by several other interveners including CAB, suggested that the monitoring of the environment should be

accompanied by an audit of the success of the EIA in predicting impacts. The Board agrees and would require the successful applicant to develop such a program, and would further require public input into its design.

In comparing the environmental aspects of the two proposals, the principal advantage to the Husky proposal is that total regional emissions of SO_2 would be reduced. As a result, the models predict that there would be fewer occasions when ground-level concentration standards are exceeded. This reduced level of SO_2 emissions, in terms of impact on the environment, is offset to some extent by concerns about continuing sulphur dusting and sulphur block fires at the Ram River plant. Also, vegetation in the general area might be less affected by the dispersion of the emissions over a larger area, which would occur if a Shell plant provided a new point source for SO_2 emissions a considerable distance from Ram River.

The CO_2 emissions would be similar for each of the proposals and the NO_x emissions would be slightly lower for Shell.

There is little to choose between the two projects in terms of potential impacts on surface and groundwater, but the existing sulphur dusting and other contaminant source problems at Ram River give a slight advantage to the Shell proposal. The same is true with respect to potential impacts on soils. There is similarly little difference in terms of impacts on wildlife and fish, but Shell may have a modest advantage due primarily to the expectation that unwanted access could be better controlled for its project.

Overall, the Board recognizes the real advantage of the reduced SO_2 emissions related to the Husky proposal. However, it believes the advantages which the Shell project would have with respect to most other environmental aspects offsets a considerable portion of the Husky advantage. The Board therefore concludes that the Husky project has only a modest environmental advantage over the Shell project.

9 RISK TO PUBLIC SAFETY

In this section of the report, the Board first analyses the risks to public safety which might result from the projects. It then deals with the need for emergency response planning.

9.1 Risk Assessment

9.1.1 Introduction

The Board has for many years enforced policies regarding sour gas emergency planning zones and the establishment of appropriate setback distances between the public and sour gas facilities, including wells, pipelines, and processing plants. Setback guidelines have been established using a combination of predictions of atmospheric dispersion behaviour, risk assessments, judgement based on actual sour gas releases from blowouts and pipeline ruptures, and the results of field simulations of sour gas releases.

Drilling for, producing, transporting, and treating sour gas can present a number of difficulties, including fouling and coagulation of drilling fluids, or rapid stress corrosion or hydrogen-induced cracking of metals. If high H_2S sour gas is released into the atmosphere, it may,through inhalation, be toxic to humans and animals proximal to the release. Over the years, improved design of equipment and procedures have been implemented. These improvements in the handling of sour gas have reduced the risks to industry workers and members of the public.

Despite these achievements, public concerns regarding sour gas have continued. The Board has acknowledged these concerns in a number of ways, including recent work on the development of new models (GASCON and GASRISK) to analyse the atmospheric dispersion of gases and the risks resulting from sour gas releases. Their development included an extensive field measurement program. The issue of whether or not the hearing should be delayed pending completion of this work was raised at both the pre-hearing meeting and at the outset of the hearing itself. Although the work was at a pre-release stage, Board staff were able to assist the applicants and interveners in successfully applying the new GASCON and GASRISK models to the respective Caroline proposals.

Sufficient time for review of the model results appeared to be provided over the course of the hearing to satisfy intervener questions and concerns. Both applicants contended that the GASCON and GASRISK results supported the work on project-related risk that they had already submitted.

9.1.2 Risk Terminology

The word "*risk*" can be used to describe hazards, chances, or odds. In the context of this report, risk is the frequency of an event times the consequences of the event. Therefore an event which has a low probability of occurring but severe consequences if it does occur may have an equal risk value to a higher probability event with small consequences.

Individual risk is the probability of death per year for an exposed individual. Societal risk is the number of estimated fatalities in a specified period of time, in an exposed group.

Comparative risks are often done on an annual average individual risk basis, eg.—as an individual has around 200 chances in a million of being killed in a motor vehicle accident each year, but less than 1 chance in a million of being killed by lightning. These comparisons are useful, but it must be recognized that some risks are voluntarily accepted by individuals, while others are not.

Individuals are generally prepared to voluntarily accept risks which are higher than the risks which may be involun-tarily imposed on them.

In their risk analyses, both applicants dealt primarily with possible human mortality due to acute toxicity from a short-term accidental high H_2S sour gas release. The issue of long-term human health effects of sulphur gases (e.g. SO_2) at lower concentrations is addressed in Section 10.2.8 of this report. The focus of the review by the applicants was on the potential risk from a sour gas release; however, both dealt with other risks such as a NGL pipeline release and fires or explosions at processing facilities. The risks to the public related to these facilities are significantly less than risks due to sour gas releases from high H_2S volume pipelines or wells.

9.1.3 Risk Criteria

Neither Alberta nor Canada has regulatory guidelines setting levels of acceptable industrial risk. Canada's Major Industrial Accidents Coordinating Committee (MIACC) is currently formulating risk assessment guide-lines for Canadian municipalities, and the Board is involved in this committee.

There was considerable discussion at the hearing on standards of other countries regarding levels of acceptable risk. The United Kingdom was referenced by Husky as having established an upper and lower level on individual and societal risks, but Husky took no position on this evidence. Shell said that it did not attempt to establish an *acceptable* individual risk number, and added that population density is a factor that must be considered.

The Board accepts the position of both appli-cants on the issue of not establishing risk criteria or acceptable risk levels as a result of the Caroline applications. Through further work by groups like MIACC, such criteria may eventually be established, as has been done by the Health and Safety Executive for the United Kingdom. However, in the interim the Board believes that judgements regarding the acceptability of various levels of risk should continue to be based on the best scientific appraisal of the level of risk, the nature of the proposed project and the benefits which would flow from it, the location of the project relative to population centres, and the mitigative measures proposed by applicants.

9.1.4 Risk Assessment for the Caroline Proposals

Shell provided risk estimates for the completed wells, the proposed field gathering system, the Site E gas plant, and the possible future Bearberry facility. Shell stated that there would be additional wells drilled in both the Caroline and Bearberry fields, but no estimate of risk over the life of its project was given. Shell did provide an estimate of how risk would change from year one to year seven of the project. Shell did not consider risk from capped or abandoned wells.

Husky provided risk estimates for its proposed gas transmission plant at Site E, the sour gas transmission pipelines, and the incremental risks at an expanded Ram River plant. The estimates were for the first year of operation, which it assumed to be a maximum. Husky did not provide information on the field gathering system or wells.

Neither applicant provided risk estimates for existing facilities in the area, the incremental traffic, or for changes in population which would result from the Caroline project. Shell did, however, look at overlapping risks from facilities that it proposed.

When the new models became available, both applicants made calculations using GASCON and GASRISK for their respective Caroline proposals. When compared to their previous work, the GASCON and GASRISK models generally showed risk to be less. The Board generally concurs, but notes that there were a few situations where the new models showed a higher concentration of H_2S and subsequently a higher probability of lethality. However, final risk assessments are a summation of many possible cases over the range of events. For this reason, the Board believes that those few situations would not significantly affect the basic risk assessment and believes that the focus of attention should be on the risk studies included in the applicants' original submissions.

The Board notes that the GASCON and GASRISK model work pointed out that matters such as horizontal versus vertical plume jets and indoor/outdoor air exchange rates have a significant influence in assessing levels of risk. Similarly, the type of dispersion co-efficients used and the well blowout and pipeline rupture statistics are important.

Shell suggested that the risks from its project would range from approximately 2 to 8 in a million for individual annual risk at existing setback distances. For societal risk, Shell said that 13 would be the maximum number of fatalities, with a probability of occurring once in a million years. The risk estimates supplied by Husky were of the same order of magnitude, but as indicated previously, its estimates excluded the wells and field gathering system. These facilities represent, by far, the greatest portion of the total risk associated with either proposal.

Shell claimed that Husky's sour gas transmission pipelines would present an incremental risk, and using Husky's own numbers, it estimated that the risk would be approximately double that of Shell's proposal. Shell said that although Husky could safely transport the gas for the Caroline project, to take on additional risk when lower risk alternatives are available would not be prudent. Husky countered that while its calculations were highly conservative, if Shell had used the same calculation procedure, Husky's proposed transmission pipelines would produce some incremental risk, but much lower than Shell's estimate.

The Board has made a detailed evaluation of the risk assessment evidence put forward by each of the applicants. With respect to Shell's submission, the Board believes that the well blowout statistics used by Shell might have under-estimated the chances of a blowout. However, because Shell used a very high flow rate, based on the maximum absolute open flow (AOF), the overall increase in risk associated with the wells would not be great. The Board also believes Shell may have over-estimated the beneficial effects that would result from its special pipeline design measures, and therefore slightly under-estimated the chances of a gathering system release. Combined, these adjustments might increase the range of individual risk associated with the Shell project by about 10 per cent.

Regarding the Husky proposal, the Board agrees that Husky's calculations of risk were more conservative than were Shell's. Adjustments for several factors, such as the particular dispersion co-efficients used and the indoor/outdoor air exchange rates, would lower the calculated risk. If adjustments are made to recognize the possibility of a horizontal release, the calculated risks would increase. However, the most significant difference between the Husky and Shell assessments relates to the chances of a pipeline rupture. Shell indicated that its special measures, some of which are described in

Section 2.2.1, would greatly reduce the chances of a release, and the Board generally agrees. Husky stated that if its project were approved, it would institute similar measures for its proposed sour gas transmission pipelines. On the basis of this undertaking, the Board would reduce the risk associated with Husky's sour gas transmission pipelines by a factor of three or four. The Board believes that with such an adjustment, Husky's proposed sour gas transmission pipelines would represent an increased risk to the public when compared to the Shell project, but not a doubling as suggested by Shell. The incremental risk of the Husky project would likely be in the range of 10 to 20 per cent when compared to the Shell project, because the Husky transmission pipelines would be situated in a sparsely populated area and also because pipelines in general have lesser risks than wells.

At least one intervener suggested that the Husky transmission pipelines should have more block valves to reduce potential release rates. The Board does not believe this is warranted having regard for the fact that Husky already considered its risk estimates in order to optimize valve locations. The optimization process includes the fact that at some point, it would not be prudent to have additional valves as these are placed on the surface where they are subject to exposure and third-party damage. Other interveners expressed concerns that the incremental risks associated with the Caroline project should be added to those which now exist. The Board notes that while the level cannot be determined accurately, there is some existing risk. Based on its understanding of the number and types of existing wells and pipelines, the Board believes the current maximum individual risk is less than 1 in a million; therefore, the current level of risk would not significantly alter the conclusions reached above.

9.1.5 Mitigative Measures

The Board notes that both applicants have identified and committed to measures to reduce risk that go well beyond the current Board and industry standards. Shell's special measures include increased pipeline wall thickness for buried sour pipelines resulting in a 30 per cent lower stress level, and deeper burial depth. The Board also understands that individual sour pipelines would be designed to accommodate internal pipeline inspection tools and that a baseline inspection would be performed. Detailed stress analysis would be conducted for the entire length of all sour gas pipelines using site-specific soils data. Shell's use of a sophisticated mass-balance leak detection system would enhance the operating reliability of its pipelines and likely reduce risks. The installation of three ESD valves at each well site would also reduce the risk of any well continuing to produce in the event of a pipeline failure.

The Board agrees that Husky's proposed dual transmission pipelines would reduce the release volume resulting from a pipeline failure. Husky's implementation of baseline surveys immediately following construction and subsequently at regular intervals during operations would also be helpful in preventing a release. Additionally, Husky's pipeline stress level would be at 47 per cent, which would assist in alleviating concerns of a pipeline failure. Should a pipeline failure occur, Husky's proposed compensated mass balance system would assist in a quick detection of a leak. Husky also indicated, in response to certain interveners, that it would investigate placing berms at valve sites to deflect horizontal jets into the atmosphere.

The Board believes that the mitigative measures proposed by each of the applicants

would be adequate to minimize risks. However, if Husky's project were approved, it would be required to adopt sour pipeline design measures for all of its pipelines similar to those proposed by Shell.

9.1.6 Setback Distances

Setback distances are the minimum distances between sour gas facilities, including wells, and residences and other public facilities. The minimum distances are set out in Interim Directives *ID 81-3* and *ID 87-2* and the associated amendments. BLCOA proposed that a new setback distance from any large group of people should be at least 3.5 km for either Shell's or Husky's proposal. A technique for calculating the 3.5 km was also provided. The Board notes that most of the large groups in the area are situated at distances greater than 3.5 km. The Brunners also requested increased setback distances.

While the Board recognizes that an increased setback distance might provide some additional safety margin, given the estimated level of risk for the proposed facilities, the Board is not prepared to increase the required separation distance. In taking this position, the Board is also recognizing the tendency for risks to decrease as reserves deplete. In this regard, some interveners have suggested that the risk will increase with the age of facilities. Historical data shows that this has generally not proven to be the case.

9.1.7 Conclusions Respecting Risk Assessment

The Board believes that the risks to public safety would be acceptable under either proposal, provided that all proposed mitigative measures were fully implemented, great care and caution were exercised in all operations, and proper emergency response plans were in place. In terms of a comparison, the Shell proposal has an advantage because the addition of the Husky sour gas transmission pipelines represents a small but real additional incremental risk.

9.2 Emergency Response Planning

9.2.1 Introduction

The Board will require that a comprehensive emergency response plan is in place prior to start-up of the Caroline project to ensure public safety in the event of an accidental H_2S release. Shell and Husky have both prepared preliminary emergency response plans designed to address the needs of their respective proposed facilities. These plans must ultimately incorporate detailed resident information and would be reviewed and approved by the Board prior to implementation. This would occur before plant start-up.

9.2.2 Response Plan Co-ordination

Shell developed its Emergency Procedures Manual assuming a single operator managing a completely integrated gas plant and gathering system. Thus, the Shell proposal would have one control centre for plant and field operations.

Husky's Emergency Procedures Manual is intended to be incorporated into the existing Ram River Emergency Procedures Manual. Husky stated it would monitor the Caroline field and gathering system, Site E gas transmission plant, sour gas transmission pipelines, and the expanded Ram River plant, from both the Ram River plant and the proposed Husky gas transmission plant. According to Husky, an emergency response for the plants and the transmission pipelines would be Husky's responsibility while an emergency response for the wells and gathering facilities would be Shell's

responsibility, and both companies would jointly handle the common point or points of overlap. Husky indicated that its personnel would be available in a back-up mode for the gathering system and field facilities should conditions warrant.

The Husky proposal would involve the co-ordination of the Husky Ram River Emergency Response Plan for the transmission pipeline system and the Shell Caroline Emergency Response Plan for the wells and gathering system. Husky's proposal would also potentially involve as many as four control centres, two at the expanded Ram River plant, one at the Husky Caroline gas transmission plant, and another control centre for the Shell gathering system.

The Board accepts that Shell's proposal, in which the plant would be close to the field and which would use a single emergency response plan for the entire area, has the advantage of simplified communications and would likely result in more effective emergency response capability. However, although the Board has always encouraged "*one operator*" emergency response plans for sour gas plants and gathering systems, the Board notes that currently there are several plans, approved by the Board, which have separate operators for the gathering systems and sour gas production facilities.

While the Board believes a suitable plan could be developed for Husky's project, the relative lack of complexity gives the Shell proposal an advantage. A very detailed communications plan linking a number of centres together would be required should Husky be the successful applicant. If that were the case, the Board would expect Husky to prepare a response plan that clearly defines the separate and joint responsibilities and the appropriate emergency response procedures.

9.2.3 Single Road Access

During the hearing, several interveners raised concerns regarding evacuation problems where single road access exists. BLCOA pointed out the single road access route from the Burnstick Lake Development. CRAG, representing families located near the proposed north compressor site, discussed the problem of single road access in the direction of the north compressor station. In particular, CRAG noted the limited access possibilities for several of its members who are located at the end of a dead-end road.

The Board concurs that any emergency response plan for the Caroline field must address this problem and provide an appropriate evacuation scheme for areas with single road access. One possible solution may be the construction of some additional or alternative access roads for the affected individuals. The Board would require the successful applicant to explore all possible solutions with affected parties to resolve these evacuation problems.

9.2.4 Warning Systems

Concerns regarding effective warning systems were also raised at the hearing. BLCOA recommended the installation of two permanent first alert warning systems at the Burnstick Lake Cottage Development and at the public campground, to give audible warning of a potential hazard. The Brunners expressed a lack of confidence in the effectiveness of either the phone system of notification or the personal operator visit notification method and also proposed a remote control warning system.

In the past, the Board has not encouraged the use of audible warning systems, such as sirens, for emergency purposes. Sirens must be tested on a regular basis and in winter

weather conditions they may not always be dependable. These devices are targets for vandals, and constant education of the public is required to ensure that warnings are understood. Notwithstanding these potential problems, sirens can be and are utilized as warnings. The Board agrees with BLCOA that some form of early warning is appropriate for the Burnstick Lake Cottage Development and campground because of the general absence of telephones. It would therefore require the successful applicant to install sirens or some mutually acceptable alternative at these locations.

While the Board acknowledges the health and safety issues raised by the Brunners, the Board cannot agree with Mrs. Brunner that the phone system and personal visits by operators are not effective for communication in emergency situations. It is the Board's experience that the combination of these notification methods during emergencies has proven to be reliable. The Board would require, however, that the successful applicant specifically identify Mrs. Brunner's desire for early notification in its emergency response plan.

The Board would also require that comprehensive air monitoring instrumentation be located in the vicinity of the Brunner property, to record the type and source of possible fugitive emissions. Placement and duration of air quality monitoring equipment should be mutually agreed upon by the operator and the Brunners. If necessary, the Board would assist in such discussions regarding the location and type of monitoring equipment and would expect to involve Alberta Environment. The Board believes that this air monitoring equipment should be installed and operational by the successful applicant for at least 1 year before start-up of the Caroline facilities.

The Board believes that Mrs. Brunner's request to have safety equipment for herself and family on the property should be deferred at this time. The Board believes that the data from the previously referred to air monitoring equipment should be jointly reviewed with the Brunners after the facilities have been in operation for at least 6 months. If that review suggests there is a problem, appropriate action would then be taken.

9.2.5 Emergency Planning Zones

Each applicant proposed a 4-km radius for its emergency planning zone. Within the zone, the public would be knowledgable of the plan, and actions to be taken in the event of an emergency would be detailed. The Board has considered BLCOA's proposal with regard to the Husky application that a second planning zone be established extending up to 16 km. The Board believes that extending the zone to 16 km would make it very difficult to manage and is unwarranted given the risk. The Board also notes that Shell is proposing a further 4-km awareness zone around the 4-km planning zone for its Caroline project. Residents within this zone would be made aware of the emergency response plan and how it operates. The Board would require Husky to have a similar 4-km awareness zone but would not adopt the 16-km recommendation. Notwithstanding the awareness zone, the Board would require that the proposed 4-km planning zone be extended to include nearby centres of population, specif-ically the town of Sundre, Burnstick Lake community, and the area around Westward Ho.

9.2.6 Community Input

The Board notes that either proposal would involve a construction period of at least 2 years. An emergency response plan would not

be required until several months before start-up of the facilities. The Board therefore believes that either applicant would have sufficient time to develop an emergency response plan that would reflect input from the residents in the Caroline project area.

In order to accomplish this task, the Board believes that the successful applicant should establish an Emergency Response Awareness Committee in conjunction with a community-based committee as suggested by CAB and discussed in Section 3. This committee should be made up of a broad cross-section of community leaders, concerned citizens, local government officials, and other industry representatives. The committee would provide the successful applicant with community input and concerns respecting the emergency response plan.

The Board believes that with input from the proposed Emergency Response Awareness Committee, either Husky or Shell could prepare an emergency response plan that adequately addresses the concerns of the interveners, and also be acceptable to the Board.

9.2.7 Conclusions Respecting Emergency Response Planning

The Board finds that the emergency response proposals submitted by Shell and Husky meet the Board's requirements for such plans. The Board does, however, have some concern with regard to the co-ordination of separate emergency plans and the communications between the different control centres, should Husky be the successful applicant. It thus sees an advantage for the Shell proposal.

The Board would like to comment on an item which was not raised at the hearing, but is an important part of an emergency response plan. The Board's ignition policy for sour wells is designed to ensure that if there is an uncontrolled or partially controlled H_2S release which could endanger health and safety, the public is to be protected by either evacuation from the area or, if evacuation is not practical, by ignition of the well. To accomplish this, the Board requires immediate ignition of an uncontrolled release from wells that have a very high potential H_2S release rate and are located near population centres where evacuation would not be feasible. The only exception where ignition could be delayed would occur if the Board is satisfied that control could be quickly regained and that the health and safety of adjacent residents would not be at risk. The Board believes that this policy applies to the Caroline project wells and would expect the successful applicant to reflect the policy in its emergency response plan.

10 SOCIO-ECONOMIC IMPACTS

10.1 Introduction

Both applicants submitted an SEIA that examined the effects of their respective proposals on the project area. It should be noted that each applicant's definition of the project area for socio-economic purposes was different. Shell considered its proposal to affect an area that included the communities of Caroline, Sundre, Rocky Mountain House, Olds, Innisfail and Didsbury, as well as portions of the MD of Clearwater No. 99 and the County of Mountain View No. 17. Husky's project area was somewhat smaller as it excluded the communities of Olds, Innisfail, and Didsbury. The differing definitions of project area were, in part, because of the different locations of the proposed facilities.

The Board has attempted to identify both the possible negative social impacts and the social benefits associated with each project. Impacts were examined to ensure that any negative impacts are reasonably acceptable and are offset by benefits to an appropriate degree. They were also compared to determine whether either project holds an advantage in terms of this particular aspect of the public interest.

It should be noted that while certain other matters, such as environmental impacts or risks to safety, also have the potential for social impacts on a community, they are dealt with elsewhere in this report.

10.2 Social Impacts

10.2.1 Traffic

Shell estimated that incremental traffic on area roads during peak construction of its project would range from 930 to 4575 vehicles per day. The most significant increases in traffic would occur on the road south of Caroline and north of SR 587. To reduce the negative impacts associated with increased traffic on local roads, Shell planned to upgrade major traffic routes in the vicinity of its proposed plant at Site E. These improvements would include reducing corners, widening and grading roads, and eliminating dust by hard surfacing the Caroline road. Shell also planned to bus transport non-local construction workers to the job sites during the proposed 4-day work week in order to help to reduce traffic, particularly on weekends.

Husky estimated that incremental traffic on area roads during peak construction would range from 1031 to 3218 vehicles per day. With a wider distribution of its construction camps as compared to the Shell project, increased traffic from the Husky project would be spread over a broader area. The secondary road south of Caroline, in particular, would see much less incremental traffic under Husky's proposal. The same upgrades to secondary roads around Site E and the field and gathering area would occur whether the Husky or Shell project proceeded.

The Board believes both applicants have undertaken adequate steps to control the impact of incremental traffic during construction, although on-going co-operation with local governments will be needed. Husky's proposal offers a slight advantage, as the increased traffic would be spread more evenly throughout the region, and not concentrated near urban areas. Whichever project proceeds, the Board agrees with the Mountain View Group that the proponent should attempt to schedule work shifts such

that the peak traffic would not coincide with school bus times. If the Shell project proceeds, the Board agrees with the suggestion from the same group that efforts be made to minimize the chances of an accident involving a school bus and a sulphur unit train. The Board would expect Shell to work with CP and others towards that objective.

During the operations phase, both applicants considered incremental traffic to be relatively minor and to pose no significant social impact on the region. The Board concurs with this assessment.

10.2.2 Noise

Large industrial projects in rural and recreational areas have the potential to raise both short- and long-term concerns regarding increased background noise. Short-term impacts usually arise during the construction period from sharp, loud, intermittent noise sources. Long-term impacts generally occur during the operating phase and may result from a general increase in ambient sound levels from vehicles, compressors, and other similar sources. During construction, the develop-ment activity schedules at Site E for either Shell or Husky would be similar, and both applicants' proposals to upgrade area roads and install self-contained construction camps would help minimize traffic-related noise during construction. In addition, all heavy trucks would use Highway 22 and SR 587, thus avoiding the Caroline townsite.

The major difference between the two proposals, in terms of noise during construction, appears to result from the smaller plant required by Husky at Site E. Husky would have an advantage because the attendant camp and activity levels would be less than required for the Shell proposal. Husky's expansion of the Ram River plant, because of its remote location, would also not result in significant noise impacts. The Board notes that while Husky tentatively proposed a construction camp for the transmission pipelines in the Ricinus area, no evidence was presented regarding methods to control noise impacts or the risk of such impacts occurring at this site.

Shell committed to meet or surpass the Board's current noise guidelines[6] and it included a number of noise control features in the design of its proposed facilities, including electric drive compressors equipped with variable speed fans. Shell retained acoustical consultants to conduct a noise impact assessment to ensure that the design of Shell's proposed facilities would keep noise level increases to an acceptable minimum. The locations that were chosen for the assessment included twenty-six permanently occupied or seasonal residences on lands in the vicinity of Shell's three proposed compressor sites and the proposed gas plant location. The assess-ment indicated that all of the predicted sound levels from the proposed Shell facilities would be below the required nighttime and daytime values at all the residence locations. Shell stated it would also complete a post-construction noise survey to ensure the noise control requirements were being met.

PALSS expressed concern about potential noise problems at the Shantz sulphur loading facilities due to the railroad. Shell did not supply any specific information on what measures, if any, may be taken to mitigate against excessive noise levels at Shantz. Notwithstanding, the Board notes that *ID 88-1* would apply to the Shantz facilities and Shell's commitment to conform to the guidelines should keep noise to acceptable levels.

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(6) Interim Directive *ID 88-1*, Noise Control Directive, October 1988.

Experts for CRAG projected a larger traffic noise impact for the Shell project than predicted by Shell. This was due to CRAG's view that there would be a need for more goods and services for Shell's proposed camp and for a greater number of social and recreational trips by the workers than Shell had anticipated. The Board cannot accurately predict what the actual associated traffic will be but expects traffic impacts would be somewhat greater for Shell's proposal, most of which is in a populated area, as compared to Husky's. Regardless of which project proceeds, the Board would expect either applicant to monitor the situation closely for possible traffic noise impacts, and take the action necessary to adhere to the noise control requirements.

The Board notes that both Shell and Husky have committed to meet or surpass the requirements of *ID 88-1*. The Board believes this is an achievable target given the remoteness of the Ram River plant for Husky and the three-phase noise assessment program committed to by Shell. Overall, with respect to noise, the centring of the Husky proposal at the somewhat remote existing Ram River plant location gives Husky's project an advantage over Shell's.

10.2.3 Visual Impacts

The degree to which the visibility of a facility affects a population depends on the physical size of the facility, the number of people in the vicinity, the degree to which the facility corresponds to existing land use, and the general population's perception of the facility.

For both the Shell and Husky projects, the visual impacts of the wells and gathering system would be equal since they would be designed, built, and operated in a similar manner for either proposal. Although visual impacts would likely be significant during construction of the gathering system pipelines, almost half of the proposed ROW is on cleared agricultural land and would be reclaimed after construction. Each of the three compressor stations would have a 75-m emergency flare stack, but there would be some natural tree-screening. At the compressor stations, lights would be shaded, facilities would be painted earth tones where practical, and the sweet gas pilot flame burning at the flare stack would be partially shielded by a windshroud, thereby making the flame less visible.

Visual impact of Shell's proposed liquid sulphur pipeline should be slight after completion of construction and ROW reclamation as approximately 60 per cent would traverse presently cleared agricultural land. The proposed Shantz sulphur forming and handling facilities would be located in a mainly cleared agricultural area adjacent to the Mobil Harmattan gas plant, and the presence of the existing plant should lower incremental visual impacts. However, this facility would likely be visible from some local roads and possibly from the homes of some nearby residents.

The most visible Shell facility would be the proposed sour gas processing plant at Site E. Although there would be no sulphur block at the site, the proposed gas plant would include one 85-m incinerator stack and one 85-m emergency flare stack. Shell indicated it would inject steam into its proposed plant flare to help reduce smoke and flame visibility. Shell's proposal would require development of 60 ha of land, a portion of which is presently cleared. Trees to the east of the plant would be maintained as a partial sight barrier. A 1000 to 1200 person construction camp at the proposed gas plant location would be required as well as a 400 to 500 person camp at an as yet undetermined location, but likely near James River Bridge.

Husky's proposed Caroline gas transmission plant at Site E would be situated in a currently cleared area of approximately 10 ha, and would likely also be partially screened by stands of trees. Husky's gas transmission plant would utilize one 78-m-high emergency flare stack and the maximum height of its other plant processing vessels was estimated to be about 24 m. Two of the proposed Husky construction camps would be located in more remote areas, while a 300 person camp would be located near James River Bridge as part of the camp required for construction of the gathering system. A smaller 100 person camp would be located at Site E.

The greater part of the ROW for the Husky transmission pipelines would be through forested land, and reclamation procedures would lessen the visual impact. Nonetheless, the linear development in a forested area would be visible. The new processing facilities, proposed for the expansion of the Ram River gas plant, would have a low incremental visual impact because of the presence of the existing plant and the absence of a permanent population in the area.

The Board believes that all the proposed facilities represent some industrial intrusion into a rural setting. Recognizing the efforts by the applicants to minimize the impacts, the Board considers the visual impacts of both projects to be acceptable. It notes that both Shell and Husky have taken visual impact into account during selection and design of their respective facility sites.

The Board believes that the visual impacts of the various permanent components of either project are essentially equal, with the exception of the proposed facilities at Site E and the clearing for Husky's transmission pipelines. Although Husky's proposed Caroline gas transmission plant would be visible to nearby residents, it would be smaller in areal extent and height than Shell's proposed facility, and would include one 78-m stack as opposed to the two 85-m structures proposed for the Shell plant. In terms of visual impacts, the Board considers the overall size of the Site E facility favours the Husky configuration, although this is somewhat offset by the additional forest clearing associated with the Husky transmission pipelines. As Husky would have fewer construction workers located in populated areas than would Shell, the visual impacts of the Husky construction camps would also be somewhat less. In general, the visual impact of the Husky proposal would be less than for the Shell proposal.

10.2.4 Odours and Fugitive Emissions

The Board recognizes that operators of sour gas facilities cannot completely control odours and fugitive emissions, and this causes concern for residents in the area. The stated objective of both applicants was to ensure that there would be no significant nuisance odours from the field, the Site E facilities, or the Ram River plant, and that the latest technology for odour abatement would be incorporated into all the facilities.

Shell stated that it would utilize back-up safety features on all valve, pump, and compressor seals and that vapours from vessels would be collected and sent to the flare system. Shell said it would perform periodic audits, routine monitoring with permanent and portable H_2S detectors and routine plant maintenance as part of its on-going leak detection system. Shell indicated that odours could virtually be eliminated by appropriate equipment design selection and audits.

Husky stated it had not finalized the details regarding the design of its vapour recovery system. However, it stated it would ensure that all process vessel relief and vent valves would be connected to the flare system and

that its vapour recovery system would be incorporated to remove odours from both the condensate storage tanks at Site E and the sour water stripper. Sour water would be collected in a pressurized vessel at its proposed gas transmission plant and the sour water vapours would not be vented to the atmosphere.

Husky's project would have fewer process vessels at Site E than Shell, which would reduce the likelihood of fugitive emissions. The Shell proposal, on the other hand, would offer less chance for sulphur handling emissions at the Shantz site than would be the case for Husky at its Ram River complex. However, as Shell's Shantz facilities would be in a more populated area, appropriate odour abatement measures would be crucial.

With respect to odours and fugitive emissions, either proposal would be satisfactory to the Board subject to certain conditions, and neither applicant appears to have a significant advantage. If Shell's proposal were approved, the Board would expect to review the results of the monitoring program, particularly the effectiveness of the proposed leak detection system. If Husky's proposal were approved, the Board would require that each condensate storage tank at Site E have an appropriate floating roof similar to the design proposed by Shell. The Board would also require Husky to increase its proposed inspection frequency of both Site E and transmission pipeline facilities.

10.2.5 Community Infrastructure

A large development project, particularly when located within a rural, sparsely populated area, can result in strains upon the existing services infrastructure within the community. Both projects would impose some costs on the local community infrastructure, mainly because of costs associated with road construction and expansion of some social services.

Both the Shell and Husky projects would require approximately $5 million of improvements to roads around Site E and the proposed field and gathering facilities. Some of the road improvements, such as the Caroline road from the village south to SR 587, would be cost-shared between Shell and the M.D. of Clearwater. Other roads, such as the 4.8 km of SR 587 west of Highway 22, would be paid for by Alberta Transportation. In addition, the Husky project proposes a $4.3-million upgrade to the Swan Lake road to be paid by the working interest owners.

Evidence provided in the Shell and Husky applications, and supported in submissions from local governments, indicate that sufficient schools and hospitals exist in the project area to serve the expected population influx. Some additional staff may be required, however, for social and mental health services, particularly during construction. The Board agrees with the suggestion of CAB that the successful applicant should be required to work with the local communities to ensure that the appropriate health and social service infrastructure is in place for the construction phase.

A number of interveners raised the issue of safety and security, particularly in the Caroline and Burnstick Lake areas. Shell stated it would work with the RCMP to ensure that security matters are addressed. Shell indicated that some mitigative measures such as increased working hours and a 4-day work week should significantly reduce these potential problems.

The Board is not prepared to condition an approval requiring the detailed security measures program requested by BLCOA for the Burnstick Lake area. The Board would, however, expect the successful applicant to work with the community, the RCMP, and others as appropriate, to minimize the impact that the presence of a large workforce might

have on security, not only at Burnstick Lake but elsewhere in the region.

The Board concludes that the existing community infrastructure in the area would be adequate, should either project proceed. The modest difference in infrastructure costs incurred by the two projects is not considered to be significant in evaluating their relative merits.

10.2.6 Land Use

In addressing the question of land use, the Board has had regard for the amount of land required for each development, the current land use, and the ease and speed with which the land could be restored.

The total land area required by the Shell proposal (886 ha) and the Husky proposal (803 ha) is generally comparable, despite the use by Husky of its existing Ram River site for the majority of its proposed gas processing facilities. A lesser portion of the proposed development would occur on public lands (*the Green Area*) in Shell's case than in Husky's.

Both proposals would involve the same wells and gathering system, which are located primarily on private lands within the White Area where current land use includes both scattered woodlands and agricultural lands. It is expected that along the pipeline ROWs in the White Area, agricultural use could be restored rapidly, while well sites, compressor stations, and access roads would remain in place over the life of the field, which is estimated to be more than 20 years, before being reclaimed. In the Board's view, the proposed gathering system is consistent with local and regional land use criteria and is therefore acceptable.

The Shell project would require development of approximately 60 ha for its proposed plant site, some 27 ha for the sulphur forming and handling facilities at Shantz, plus temporary disturbance of about 141 ha of land for the liquid sulphur pipeline. Roughly equal disturbance of agricultural lands and of woodlands would be required to develop these facilities. Restoration of the liquid sulphur pipeline ROW to current agricultural use would likely be within 2 to 3 years, while land use changes at the remaining facilities would continue over the project life.

In the Husky proposal, changes in current land use would be required for Husky's smaller gas transmission plant at Site E (10 ha), for the sour gas transmission pipelines (133 ha), and for the associated access roads (65 ha). All these developments would be on public lands, zoned for multiple use within the Green Area. In Husky's case, the greater part of the land disturbed currently contains merchantable timber. This land use would be lost over the life of the project, although the pipeline ROW would be revegetated.

In general, the Board finds the land use changes proposed by both companies to be acceptable, and notes the commitments made by both firms to use existing development corridors where possible. The Board believes that Husky's proposal has a slight advantage in total land use requirements, despite some concern that the 10-ha parcel proposed by Husky at Site E for its gas transmission plant may not be sufficient. This advantage is offset by Shell's ability to more rapidly return at least some of the disturbed land to its current land use. In total, the Board sees little difference between the proposals in terms of land use.

10.2.7 Property Values

The degree to which land values in the Sundre-Caroline region would be altered by the Shell project was raised by several hearing

participants. Those interveners claimed that property values would become depressed for parcels of land situated close to Shell's proposed gas plant and to a certain extent, the gathering system facilities. In particular, they claimed that land purchased for its aesthetic characteristics, recreational use, or solitude would be devalued by the presence of sour gas facilities to a greater degree than would agricultural land.

In anticipation of such concerns, Shell commissioned two studies which reviewed sales of property in the vicinity of a range of sour gas facilities elsewhere in the province. Both studies indicated there was no measurable impact on the value of property which could be attributed to sour gas developments, and that the price of land fluctuated within the normal range of land prices. Shell also said there may even be a positive effect or increase in land value in certain cases where members of the project's permanent workforce prefer to purchase property close to their jobs.

Expert testimony provided by CRAG disputed the reports submitted by Shell. The CRAG evidence stated that major developments can have a negative effect on land prices, and that the conclusions reached by the Shell studies were not meaningful.

Husky stated that its proposal would have essentially no possibility of affecting private property value now or in the future because of the sparsely populated sites that would be used for the transmission pipelines and plant expansion and the fact that the transmission pipelines, the proposed Husky gas transmission plant, and the existing Ram River plant would all be on Crown land.

Several interveners preferred the Husky proposal since Husky's gas transmission plant at Site E would be smaller in size than the proposed Shell plant, and thus they believed it would have less tendency to discourage future potential buyers for nearby private land.

The Board believes that a large sour gas plant and its associated physical infrastructure would, despite Shell's evidence, likely have some negative effect on property values for those parcels closest to the site which might be used for residential or recreational purposes. This effect would then tend to decrease to at least a neutral or perhaps even positive effect once a certain distance from the plant was attained, because of the impact of a large project on the economy and population of a region. This distance would likely be tied to the visibility of the plant facilities as well as the perception some people may have of sour gas plant impacts. It is reasonable to expect that there would be a lesser impact on agricultural land values than on recreational/ residential properties. The Board therefore sees a modest advantage for the Husky proposal with regard to non-agricultural land values in that the proposed Husky gas transmission plant would be considerably smaller than Shell's, and also because the remainder of its facilities would be in a remote location removed from land transactions.

10.2.8 Health

Concerns about the effects that gas plant emissions may have on human health were raised by CAB, Mrs. Brunner, and a number of other participants in the hearing. The matter was also discussed with the proponents at several public meetings prior to the hearing. These discussions occurred because of a general perception in the region that a health study should be incorporated into the Caroline gas development. To address these concerns, Shell funded a study by Dr. H. Bryant of the University of Calgary to describe the methods that could be used to monitor the health of the community as the development proceeds. The study did not intend to address the question of

whether health effects would or would not occur, but the feasibility of detecting community health changes. Dr. Bryant suggested two possible studies, long-term or short-term health effects.

The study report, which was submitted with Shell's applications to the Board, was reviewed by CAB, and that group supported the short-term form of the proposal. This plan would entail the monitoring of emergency room visits at local hospitals, office visits to physicians, school absenteeism, and symptoms experienced by sensitive individuals or groups. It would start 3 months prior to gas plant start-up and continue for 1 year. The long-term health study was not supported by CAB, apparently because of the small regional population size and long latent period for some diseases, as well as the fact that regional plant emissions have declined in recent years. At the hearing PALSS requested a long-term health study. Shell committed to conduct the short-term health study if its project proceeded.

Husky did not fund or investigate any feasibility studies into public health effects, taking the position that no nearby residents exist in the Ram River region and also that the emissions from its Site E facilities would be minimal.

The Board would require that the project which proceeds be designed and operated in a manner which satisfies all existing standards, including those intended to protect human health. It would therefore not expect significant effects on health, for either project, and would not condition its approval to require a health study. If a study is carried out, the Board would urge that its design and conduct have considerable input from the broad public in the area and that the provincial government departments responsible for environment and health be fully involved.

Mrs. Brunner asked that the gas industry assist in developing an antidote for the effects of sour gas. The Board is not in a position to require this of the industry, but is making the request known.

10.2.9 Lifestyle

Perhaps the most significant of social impacts is any negative impact on the lifestyle of people in the area. These impacts can result from many factors, including some dealt with earlier in this section of the report and some dealt with elsewhere. In terms of the Caroline development, the impact on lifestyle is likely to be greatest during the construction period, regardless of which project goes ahead.

During peak construction for either project, more than 1000 workers would be required, many of whom would be hired from outside the project area. This influx of construction workers could have a significant adverse effect on the lifestyle of local residents.

The Shell project proposes two construction camps, the largest being at Site E and a smaller camp somewhere east of James River Bridge. To mitigate negative impacts on the local communities, Shell proposes that both camps be completely self-supporting, including the installation of recreational facilities. In addition, Shell intends to incorporate a 4-day work week with 10-hour shifts. This is intended to minimize construction workers' free time, encourage them to go home for weekends, and reduce traffic by providing bus transportation and shifting the travel to off-peak hours.

The Husky project proposes a minimum of three construction camps with the possibility of four. Husky said that setting up the largest camp at its isolated Ram River plant site and distributing other camps throughout the region would minimize disruption for local communi-

ties. Husky also proposes to incorporate 4-day work weeks and 10-hour shifts and to provide recreation facilities at its camps.

The Board considers both applicants to have undertaken reasonable steps to alleviate the impact of their construction camps on the lifestyle of the local communities. Although the impacts could be significant, the Board believes that either applicant, by working closely with the appropriate local representatives and adhering to all of the commitments made at the hearing, could complete construction of these projects in an acceptable manner.

In terms of comparative impacts, the Husky proposal would likely have the lesser impact as its major camp would be at the relatively isolated Ram River plant site while Shell's main camp would be much closer to urban areas.

During the operations phase of the projects, neither applicant considered its respective proposal to have significant negative impact on local lifestyles and the Board generally agrees. It does, however, expect that there could be some on-going impacts due to the increased population in the region which will result from the development. For example, there could be some inflationary pressures associated with the population influx of the newly hired plant workforce into the area. These should not be great, and neither proposal would have a significant advantage over the other in this regard.

10.3 Social Benefits

Most of the social benefits associated with development of the Caroline gas reserves would be economic gains due to increased expenditures for goods and services and to an expanded tax base. In evaluating the two proposals, the Board first examined the economic benefits which would affect the region where the gas reserves are located. It then reviewed additional economic benefits to the province and the country. With regard to regional benefits, the Board considered a relatively broad area which includes Rocky Mountain House to the north, extends east to Highway 2, and includes significant parts of the MD of Clearwater 99 and the County of Mountain View 17.

10.3.1 Regional Employment

The project area can be expected to benefit from an increase in employment during the construction and operation phases of either the Shell or the Husky proposal. Shell estimated that its project would require a total of 2265 man-years, of which 18 per cent, or 488 man-years, would be supplied locally. It also estimated that when construction activity peaks, 130 indirect jobs and 310 induced jobs would be created in the project area.

The Husky project is expected to require 1965 total man-years to construct, of which Husky expects 17 per cent or 335 man-years to be supplied locally. It estimated that 66 indirect jobs and 140 induced jobs would be generated during peak construction.

As indicated in Section 5 of the report, the Board believes that Husky has somewhat under-estimated the likely capital costs for its project. The Board also believes that the workforce required by Husky would be somewhat larger than projected in its application. Notwithstanding these adjustments, the Board anticipates slightly more local employment opportunities to be generated during the construction phase of the Shell project than would be generated by the Husky alternative. This is because the new "*greenfield*" plant proposed by Shell would be a larger construction project than Husky's proposal, where some facilities already exist.

Shell estimated that when the operating phase commences, 180 full-time jobs would be created. Of these, Shell anticipates that 75 would be hired locally. In addition to operative positions, Shell expected its operations to create 20 additional indirect jobs in local businesses and 135 induced jobs in the region. The total number of jobs created from operations is estimated by Shell to be 335.

Husky projected that 85 additional full-time jobs would be available at an expanded Ram River plant. Of these, Husky expected 50 to be filled by local residents. In addition to permanent operating jobs, Husky anticipated 18 indirect jobs and 71 induced jobs to be created in the region. The total number of jobs created from operations is thus expected to be 174.

The Board anticipates greater benefits to flow from the Shell proposal to the project area in terms of employment creation. While Shell's greater employment in both construction and operations is of greater benefit to the region, it should be noted that this is not an advantage in terms of economic efficiency.

The Board believes that the successful applicant should endeavour to hire locals where they are available and reasonably qualified. It is supportive of a suggestion by the Mountain View Group that the project operator should ensure that local high school students are aware of work opportunities and required training.

10.3.2 Regional Income

Both Shell and Husky anticipate their projects to substantially increase incomes and business opportunities in the region. In the construction phases of the projects, additional income would be injected into the region through expenditures on local labour and local purchases of goods and services. Total regional income from construction, representing the sum of net direct, indirect, and induced incomes from the projects are estimated to be $36.7 million and $37 million for the Shell and Husky projects, respectively.

The Board anticipates that regional income during construction would be higher under the Shell option as it entails slightly greater capital expenditures and would employ a larger construction workforce. The Board also expects differences in the distribution of this income within the project area. From evidence provided in both applications, the Board has estimated that for the Husky project a large portion of the regional income would be in the Rocky Mountain House area, while for the Shell proposal, there would be a more even distribution of income throughout the region.

Once operations commence, Husky anticipates total annual regional income from its project to be $5.8 million while Shell expects an annual income of $9 million to be generated in the area by its project. The Board agrees that annual regional income would be greater under the Shell project because of the larger operating workforce employed. Under the Husky proposal, the Board would again anticipate a higher concentration of annual regional income around the Rocky Mountain House area, while for the Shell project, the communities of Sundre and Caroline would receive a larger portion, and the communities of Olds, Innisfail, and Didsbury would also receive some income.

An additional factor which could bear upon the regional income from the competing projects is the expected timing. For the reasons set out in Section 5.3, the Board believes that for the Shell project, both the construction and the on-stream date for all its facilities would occur sooner than for the Husky project. This would mean that the regional income benefits

would be experienced earlier, a point mentioned as positive by a number of participants in the hearing. The Shell proposal would thus have this further advantage.

10.3.3 Municipal Taxes

There would be a benefit to the region under both the Shell and Husky proposals as new capital investment expands the tax base for municipal revenues. Husky estimated that $2.74 million in additional annual taxes would be generated, nearly all of which would go to the MD of Clearwater. Shell expected to generate an additional $2.8 million in taxes per year for the MD of Clearwater from its project and $0.4 million per year for the County of Mountain View.

The Board recognizes that the Shell project holds a slight advantage in terms of extra municipal tax revenue generated, but the difference is small. Again, the distribution of taxes throughout the region would be wider and the payments would commence earlier for the Shell proposal.

10.3.4 Provincial Royalties

The development of the Caroline gas field would generate a significant amount of royalty revenue for the Province of Alberta. Shell estimated that over the life of its project, the province would receive approximately $2 billion (undiscounted) in royalty revenue.

Husky estimated that its project would generate some $1.035 billion in Crown royalty and $0.456 billion in freehold royalty. It should be noted that the applicants used different price forecasts to estimate royalty revenues and, therefore, these numbers are not directly comparable.

The Board has evaluated both projects and determined that the Husky proposal yields slightly higher royalties for the same price scenario. The Husky project holds this advantage despite a higher estimate by the Board of plant capital costs, and assuming a 9-month delay relative to Shell because this project results in slightly lower deductions from revenues in lieu of Crown processing costs. However, the greater uncertainty with respect to the Husky cost estimates means that any royalty advantage would be eliminated if significant cost overruns occurred. The Board concludes that the preliminary nature of the Husky cost estimates and the accompanying uncertainty offset the slight royalty advantage and results in little difference between the projects.

10.3.5 Provincial and Federal Taxes

As well as providing benefits to the local project area, the Province of Alberta and the country as a whole would benefit from the tax revenues generated by either project. While no comparable estimates of federal and provincial taxes were provided by the applicants, the Board has estimated that, in present value terms, both provincial and federal taxes would be higher under the Shell project than under the Husky alternative. The Board's assumption of a 9-month delay in start-up of the Husky project from that stated in its application is mainly responsible for this result. Also, the smaller net benefit generated by the Husky proposal results in lower taxes paid to both levels of government.

10.4 Conclusions Respecting Socio-economic Impacts

The Shell project would result in major facilities being located in a relatively populated area, while the Husky project would locate some of the new facilities in more remote areas and at an existing gas plant. It is, therefore, not surprising that the Shell project would likely result in greater social impacts in

terms of noise, traffic, and other impacts on the lifestyle of residents of the area.

On the other hand, because the Shell project may involve modestly greater capital investment, would provide greater employment, and would likely commence both construction and operations sooner, on a present value basis it generally has an advantage in terms of providing additional regional income and taxes, and provides higher taxes to the provincial and federal governments. The Shell project, because of its location, would also result in a more even distribution of benefits throughout the entire region, although a significant portion of them would be centred in the general vicinity of the Caroline gas reserves. For the Husky proposal, the regional benefits would be generally centred in the Rocky Mountain House area.

The distribution of benefits within the region was an issue raised by a number of participants in the hearing. They stated that those people living in the vicinity of the gas reserves must put up with the negative environmental and nuisance effects and the potential risks associated with the field facilities, regardless of which processing project proceeds. Therefore they contended that the same region, near Caroline, should receive a significant portion of the benefits which might occur. They thus supported the Shell proposal. The Board does not consider such an argument overwhelming, but does see some merit in it and also a corresponding slight advantage to the Shell project.

Having regard for all of the socio-economic matters, the Board sees a modest overall advantage for the Shell proposal. It emphasizes, however, that either of the projects would be fully acceptable from a socio-economic viewpoint, provided all of the commitments made at the hearing were fulfilled.

At the hearing, Dr. Kostuch recommended that the successful applicant be required to develop a plan to evaluate the on-going social impacts and the success of the SEIA in predicting and mitigating such impacts. The recommendation was supported by CAB, PALSS, and others, and a variation of it was put forward by BLCOA. The Board believes the recommendation is a sound one and would make it a condition of any approval.

11 PUBLIC ACCEPTABILITY

11.1 Introduction

The extent to which the development of the Caroline reserves is generally acceptable to the public and the relative acceptability of the two respective projects proposed to recover the reserves were discussed at length at the hearing, and are factors that the Board believes it should consider.

In doing so, the Board attempted to assess the overall level of support from the general public on the basis of the evidence put forward by the members of the public that appeared at the hearing. Since it is not possible to know whether the positions presented were representative of general public sentiment, a precise assessment of this matter is difficult. It is further complicated by the uncertainty as to the criteria used by the various members of the public to establish their views respecting each particular project.

For the purposes of this section the Board has categorized the public, as represented by hearing participants, into three groups. These are local government, local business interests, and individual citizens. The local government group includes the various towns and municipal districts while the local business interests group includes individual business people and the various Chambers of Commerce.

The citizens group consists of individuals who appeared on their own behalf, and of organized groups who represented a number of individuals with generally similar interests. One citizen group, CAB, was somewhat unique in that its members were appointed by local governments in the project area. However, CAB indicated that it did not represent the local municipalities. All members of CAB are residents of the area and claimed they were speaking on behalf of a large number of other residents who were not at the hearing.

11.2 Local Government

Based on the evidence presented, the Board notes that there is unified support by the various local governments for the early development of the Caroline reserves. The governments differ, however, in their support for the specific projects.

Of those which stated a preference, the local governments generally supported the project which would be located physically nearest to them and therefore more likely to have greater positive economic impact on their community. At the hearing there was support from a larger number of local governments for the Shell project, presumably in part because the Shell proposal is located in an area that has a larger number of local governments.

11.3 Local Business Interests

Local business people, including the various Chambers of Commerce, expressed a great interest in the economic well-being of their communities. Therefore, like local governments, they strongly supported the early development of the Caroline reserves. They also generally showed support for the project which would be physically located nearest to or within their areas of influence. As there are more towns in proximity to the proposed Shell project, this led to greater support for that proposal.

A number of participants, in referring to the business community's support for the Shell project, made reference to a convoy, in the spring of 1989, organized by the Sundre and District Chamber of Commerce. The convoy attracted a large and varied number of participants which these interveners said was

an indication of strong support for the Shell project by the community and business interests in the area.

11.4 Individual Citizens

It is often difficult to draw conclusions respecting the overall views of citizens of an area based solely on the views of those who appear at a hearing. However, over 650 individuals either made submissions, signed them, or held membership in groups that appeared at the Caroline hearing. This is a considerable number given the population of the region. Additionally, CAB claimed to be speaking on behalf of a much larger group, the so-called "*silent majority*". Although this claim was challenged by other participants in the hearing, CAB members pointed to the lack of opposition to their re-appointment to the committee after municipal elections in 1989 as evidence of general community support for the position taken by CAB.

Having regard for the number of citizens who appeared or were represented at the hearing, the Board believes it has gained an impression respecting the overall views of the public in the area. In terms of developing the Caroline reserves, the Board notes that only a small portion of the public is opposed to any new development. These individuals cited environmental, safety, and other reasons for their opposition. The majority of people appeared to be either supportive of the development of the reserves, or at least prepared to accept the development recognizing that it is a very sizeable reserve from which many economic benefits could flow. The Board notes that the area residents wanted to be assured that the Caroline development would take place in a safe, environmentally and economically sound manner.

With respect to support for a specific project, most of the individuals who appeared or were represented expressed support for the Shell project, This was partly due to the large number who signed individual letters presented by Mr. Saunders. A principal reason given was that the gas reserves, and thus the necessary field facilities and possible negative impacts, were in the Caroline-Sundre area. Therefore, the plant and associated developments, with their related economic benefits, should be in the same area where the majority of people would have to accept the inconvenience of the development and the possible associated risks. There were also many expressions of trust that Shell would live up to its commitments to the local communities.

A number of individuals or their representatives favoured the Husky project, with much of the support expressed by people who owned property in the vicinity of the proposed Shell plant and other facilities, and who did not wish to receive the possible negative impacts of such a development. In supporting the Husky project, they generally pointed to the reduced total SO_2 emissions in the region as a significant environmental benefit, as well as to other environmental, safety, and economic reasons.

From the interventions presented, the Board notes that there is only a relatively small portion of people in the area who are opposed to the development of the Caroline reserves and therefore both projects. Furthermore, even with the various uncertainties and possible overlap of presentations, the Board believes that there is greater individual acceptance within the region for the Shell project than for the Husky project.

11.5 Route and Site Selection

The Board has treated route and site selection as being inherent in the consideration of the environmental, socio-economic, risk, public

safety, and public acceptability criteria, and also to some extent in operating reliability, economic efficiency, and future development criteria. In this section, the Board offers some comments on the process of route and site selection and community consultation by the applicants, and also deals with specific localized routing and siting issues raised by interveners.

The Board believes that the process of route and site selection and accompanying community consultation carried out by the applicants is very important. The selection of optimum routes and sites involves a balancing of many diverse private and public factors in a somewhat subjective fashion. Key aspects are the applicants' efforts to achieve an understanding of and to involve the community and recognize their needs in this balancing and the degree to which the community accepts the ultimate selection.

The Board notes that the applicants generally followed systematic approaches in their route and site selections, and made considerable efforts to provide for public consultation and input. The Board believes that this has resulted in the resolution of many issues and the alleviation of many concerns that would otherwise have been brought to the hearing or would remain as objections to the development.

The Board notes in particular the concerns expressed by CRAG and other interveners regarding the process used by Shell to select Site E as the proposed gas plant location. In general, the Board believes that the site selection decision-making process resulted in a reasonable compromise between a number of conflicting goals and objectives, and that these compromises are fairly reflected in the final site selected.

A number of specific suggestions regarding localized aspects of routing and siting were raised at the hearing. In reviewing these, the Board is conscious of the acceptance of the proposed routes and sites by many other persons who are also directly affected or have concerns, some of whom may not have appeared at the hearing. The Board recognizes that site changes at this time would shift or relocate the impacts, and likely result in concerns by others. Further, the Board believes that the site selection and public consultation processes used by the applicants have resulted in a great deal of consideration of possible alternatives. Thus the Board would not pursue a suggested relocation by requiring further studies and possibly re-opening the hearing, unless a suggested relocation appeared to have significant advantages and few obvious disadvantages.

The Board's view of the specific routing and siting suggestions is set out below.

- CRAG suggested that the north compressor station could be moved approximately 1 km to the west. The Board estimates that this would increase the distance from the nearest residence from about 1.6 km to about 2.4 km. This additional separation would not appear to be justified considering the additional clearing and disturbance that would result from relocation of the compressor site and connecting pipelines, and the possible risks to the Beaver Creek watershed. The Board believes that the proposed site, with a 1.6-km separation distance from residents, should not result in any significant impact on them. (The issue of emergency evacuation routes for the CRAG residents in the area is addressed in Section 9.2.3.)
- CRAG suggested that the proposed northern leg of the gathering system could be connected directly to the central leg and thus eliminate the pipeline and the north compressor which would be near some of the CRAG residents. The Board believes that this would result in much

greater volumes of sour gas being moved through a populated area. Also, it would result in the compressor having to be relocated to an area of greater resident density and hence impose a greater impact.

- CRAG suggested that Husky's gas transmission plant be relocated from Site E to the central compressor station site. The Board notes that this would result in Husky's plant and the sour gas transmission pipelines being closer to more residences and hence would not appear to be advantageous.
- The Brunners requested that the south compressor station be relocated farther away from their residence than the current 2-km separation distance. A 2-km separation from a facility such as a compressor station should not result in significant impacts. Further, the relocation of the compressor site would likely require rerouting of a substantial portion of the pipeline system which has gained the acceptance of the many other residents in the area.
- The proposed fresh water supply line from the James River to Shell's proposed gas plant would follow a route generally parallel to Amoco's proposed condensate line. The Board would require Shell, if its project proceeds, to consider the feasibility of installing both lines in the same ROW.

11.6 Conclusions Respecting Public Acceptability

The Board believes that the local governments and business interests are totally in support of development of the Caroline reserves. With the exception of the M.D. of Clearwater No. 99, which did not support either applicant, and those from Rocky Mountain House, the majority of the public support the Shell project over the Husky proposal. Even though there were some individuals who supported the Husky project, many of them appeared to do so primarily because they opposed certain aspects of Shell's project. The local citizens generally support the Shell proposal, and on an overall basis, the criteria of public acceptability appears to favour that project.

The degree of understanding and acceptance of the project by the public is partly as a result of the many efforts over the past several years to involve the public in the project planning. The Board commends these efforts and agrees with a number of interveners, notably CAB and PALSS, that public involvement should continue and should involve a cross-section of the public in the affected areas.

12 FUTURE RESOURCE DEVELOPMENT POTENTIAL

12.1 Introduction

The Board has before it specific applications from Shell and Husky to produce the Caroline gas reserves. Its focus must therefore be on these applications. At the same time, both of the applicants and a number of participants in the hearing provided evidence or commented on the ability of the Shell or Husky proposals to be integrated with future potential developments in the region. For this reason, and in order to carry out its mandate of promoting orderly and efficient development, the Board must assess the Shell and Husky proposals in relation to other possible future resource developments in the region. The Board has considered the following possible developments:

- Bearberry ultra-sour gas on a commercial scale,
- potential further sour gas discoveries in the Caroline area,
- available new gas and potential further discoveries in the foothills area served by the current Ram River plant,
- oil recovery enhancement by CO_2 flooding, and
- integration of sulphur recovery between plants.

12.2 Bearberry Ultra-sour Gas

The Bearberry field is located less than 15 km from Shell's proposed Caroline plant site and Shell has identified a suitable pipeline corridor between them. Shell has planned its Caroline plant to allow integration of Bearberry commercial production, which Shell believes could commence in less than 5 years. Shell would add oxygen-enrichment facilities to its sulphur plants to provide the required additional capacity. Shell indicated that this addition combined with some technical improvements and the recovery of the degassed sulphur vapours would potentially increase its plant's sulphur recovery level from 99.8 per cent to 99.9 per cent. Furthermore, Shell suggested that the nitrogen from the oxygen plant would be injected into the Bearberry wells to lift the sulphur solvent up the wellbore. Regeneration of the solvent to remove sulphur would take place at its proposed Caroline plant site.

Shell stated that the proximity of Bearberry to its proposed Caroline plant would reduce environmental and safety risks, and would avoid the need for solvent regeneration facilities in the field.

Husky believes that Bearberry commercial production is quite uncertain at this point and hence should not be a major factor in the consideration of the current plant applications. However, Husky indicated that from a technical point of view, Bearberry gas could be transported to and processed at its Ram River plant. It claimed that processing and sulphur capacity would become available as other supplies to the plant decline, or by increasing the level of oxygen enrichment.

The Board believes that there is sufficient probability for Bearberry commercial production to occur within an appropriate time frame that it should be considered in the assessment of the two proposals. In this regard, the Shell proposal would be considerably more suitable to accommodate the Bearberry gas without having to build a new plant in the area. The reasons for this are the shorter distance to the plant and thus the avoidance of a long-distance sour gas pipeline, and the likelihood of greater sulphur plant capacity being available because of the greater ability to introduce oxygen-enrichment.

12.3 Caroline Area Discovery Potential

There are a number of prospective oil and gas zones underlying the Caroline area. The deeper zones such as the Beaverhill Lake (Caroline) and the Leduc (Bearberry), are generally more sour and richer in liquids, and hence are the ones that would be of most significance to the current development proposals.

Shell stated that continued exploratory drilling for the Beaverhill Lake has not resulted in any new discoveries in the Caroline area. However, the Board believes that because a number of other formations such as the Wabamun, Nisku, and Leduc are gas bearing in the Caroline area, the potential for further highly sour gas discoveries does exist. The proposed Shell Caroline plant would provide higher sulphur recovery levels than do existing sulphur recovery plants in the area, and would be appropriately designed to handle new ultra-sour gas. It would also likely be more easily accessible to new gas reserves from the Caroline area than would an expanded Ram River plant.

12.4 Foothills Area Discovery Potential

Husky stated that its Ram River plant is currently under-utilized, particularly the sulphur recovery portion of the plant, and that the currently connected supplies would continue to decline in the future. Husky said that its Ram River plant could serve as a regional sulphur recovery plant for the large area in the foothills already served by its extensive existing pipeline network, along with Caroline and Bearberry. Husky pointed out that it is currently successfully transporting raw sour gas of up to 30 per cent H_2S from fields as far away as 100 km. Husky stated that it could successfully expand and operate its already large gathering and processing system. Husky provided estimates showing that 1992 production from currently connected fields of approximately 12 000 x 10^3 m^3/d, along with the 8000 x 10^3 m^3/d of proposed Caroline gas plus a maximum tie-in of 5600 x 10^3 m^3/d of other new already-discovered foothills gas, would essentially load an expanded Ram River plant. It added that future new discoveries of 800 x 10^3 m^3/d and the Bearberry gas could be accommodated as the currently connected supplies decline. Husky stated that new foothills gas alone would not increase the present low utilization of the sulphur recovery portion of the plant because of the relatively low H_2S content of this gas.

Shell expressed optimism about further gas discoveries in the Ram River foothills area, but provided limited quantitative information.

The Ram River plant and its gathering system are situated to serve a major segment of the foothills belt, and the Board believes it logical that this would continue to be its primary service area. The Board believes that there is significant potential for further gas discoveries within this area, because geological structures and reservoir zone thicknesses are considered favourable and the density of exploratory wells to date is very limited. The rate of gas development in this area can be expected to increase with improvements in gas and sulphur prices.

New gas discovered in the Ram River foothills area could be accommodated at an expanded Ram River plant more easily than at a new Shell plant in the Caroline area. However, such gas could also be processed at Husky's existing Ram River plant, perhaps more readily in terms of the availability of capacity than if the Caroline gas was also going to that plant. Additionally, the Board believes that new gas in the general Ram River area could facilitate upgrading of the sulphur recovery at the Ram River plant, even if it was not expanded in accordance with the current Husky application.

The Board is concerned about the Ram River plant alone being able to effectively provide capacity for all future sour gas processing needs for both its current large foothills gathering area, and the Caroline area including Bearberry. If foothills gas developments were to increase significantly, then future Bearberry gas or future sour gas discoveries in the Caroline area may still require a new plant, with some likelihood of lower sulphur recovery levels and higher sulphur emissions. Similarly if Bearberry gas production proved to be highly successful, then later foothills developments may require another new plant, again possibly with lower sulphur recoveries and higher emissions.

In summary, existing unconnected gas reserves or new discoveries in the general Ram River area appear to be quite promising and could be appropriately accommodated at an expanded Ram River plant. It is unlikely that the construction of a new plant in Caroline, as proposed by Shell, would preclude the handling of such gas at Ram River and indeed, could provide greater flexibility to handle such gas.

12.5 CO_2 Supply for Oil Recovery

Shell is currently operating an enhanced oil recovery scheme involving CO_2 injection in the Harmattan-Elkton oil reservoir. Shell stated that there is some possibility of a supply of CO_2 being needed for this purpose and that its proposed Caroline plant, located relatively nearby, could provide the required CO_2.

The Board understands that prospects for expansion or extension of the CO_2 injection scheme are uncertain and hence ascribes only a very limited advantage to the Shell proposal for this purpose.

12.6 Integration Between Plants

The Board believes that integration of sulphur recovery between nearby plants may be required in order to minimize or reduce SO_2 emissions in the general Caroline-Ram River area. Where one plant has, or proposes to install, higher levels of sulphur recovery and where others nearby have low levels or no sulphur recovery at all, it may be desirable to send the acid gas from the latter to the former.

Shell and Altana have submitted applications to transfer the acid gas from Altana's plant to Shell's proposed Caroline plant for recovery of the sulphur. Husky indicated that it would also be prepared to take the Altana gas to its Ram River plant.

The Board believes there is a potential for additional integration of this kind in the Caroline area. In particular, the Board intends to have Amoco examine the feasibility of transferring acid gas from both of its Caroline plants to either Shell's or Husky's project, whichever ultimately proceeds. The Board also suggests that Gulf, as operator of the Strachan plant, might consider integration possibilities in the future with Husky's Ram River plant.

In comparing the Shell and Husky applications with respect to this matter, the Board finds both projects equally capable, but notes that Shell already has arrangements in place for Altana's acid gas.

12.7 Conclusions Respecting Future Resource Development Potential

The Board sees merit in the placement of a new sulphur recovery plant in the Caroline area specifically to handle the large Caroline reserves and possibly Bearberry gas, and to leave the Ram River plant unencumbered to serve future new gas development near its large gathering area. The Board sees some possibility that the movement of new gas reserves to the Ram River plant may result in the upgrading of sulphur recovery at that plant, even in the case where it was not processing the Caroline gas.

Overall, as it relates to future development potential, the Board sees a distinct advantage in favour of the Shell proposal.

13 IMPACT OF RELATED APPLICATIONS

13.1 Introduction

The related applications considered in this section are those proposed to accommodate the various products from the plants or provide electrical power to the proposed projects. The applications are considered in two groups, associated applications and future applications. The associated applications are the Federated NGL pipeline proposals, the Amoco condensate pipeline proposals, and the proposals by Shell and Altana to deliver Altana's acid gas to Shell's proposed Caroline plant for sulphur recovery. These were considered for approval at the hearing, and the Board has evaluated them on the basis of technical soundness, environmental impacts, and landowner or occupant acceptability.

The future applications are the proposed NOVA gas installations and TransAlta power supply facilities. Recognizing that these facilities were not formally applied for and therefore could not be considered for approval at the hearing, the Board has only considered the possible effects of the facilities on the relative merits of the projects proposed by Shell and Husky.

13.2 Associated Applications

The Board finds the proposed facilities in the associated applications to be technically satisfactory. All landowners and occupants along the proposed pipeline routes of both the Federated Caroline Extension (Shell project) and the Federated Ram River Extension (Husky project) have consented to the routing and have no objection to the issuance of a permit. Also, the Board has not received any objections from landowners or occupants along the proposed routes of the Amoco condensate pipeline or the Shell acid gas pipeline.

The Federated pipeline for each project would be approximately 160 km in length as shown in **Figure 4.** Of the total length, approximately 100 km would be common to both applications. Both proposals would require a 15-m ROW with 3 m of temporary working space on cultivated land and additional ROW at river, road, and pipeline crossings. Both proposed routes would cross lands with moderately low to very low capacity for outdoor recreation. Although both proposed routes would cross key wildlife areas, neither would traverse site-specific habitat for rare, threatened, or endangered species. The proposed Federated Ram River Extension would cross two critical wildlife areas, while the proposed Federated Caroline Extension would not cross any. However, the crossings of critical wildlife areas are at locations where the proposed pipelines would be installed immediately adjacent to existing pipeline ROW. Both routes would cross fair to good ungulate habitat.

Of the total length of the proposed Federated Caroline Extension, 115 km or 73 per cent would follow existing linear development, quarter lines, or existing ROW compared to 127 km or 79 per cent of the proposed Federated Ram River Extension. Approximately 4 per cent of the proposed Federated Caroline Extension would be within the Green Area with the primary land use being cattle grazing. The rest of the route (96 per cent) would traverse the White Area, where land use includes cultivated land, hay land, improved pasture, bush, and bush pasture. The proposed Federated Ram River Extension would traverse the Green Area for approximately 12 per cent of its total length. The primary land use in this area is forestry. The remainder of the route (88 per cent) would traverse the White Area, with cultivated land, hay land, improved pasture, bush, and bush pasture as land uses. Although the proposed Federated Ram River Extension

would cross steeper terrain, the estimated capital costs are similar for both routes, at approximately $22 million.

Although the Federated applications differ in routing for approximately 60 km of their total length, the Board believes that the two proposals are very similar from an environmental perspective.

The proposed Amoco condensate pipelines would have the same routing for either the Husky or Shell projects, and would require a 15-m ROW for approximately 9 km through farm and grazing land, and a small amount of bush pasture. Amoco stated that it would explore a possible sharing of ROW with Shell's proposed construction camp water supply line from the James River if Shell's project is approved. If ROW sharing is possible, incremental impact of the proposed Amoco pipeline for the Shell project would be somewhat reduced.

The proposed Shell acid gas pipeline from the Altana gas plant to Shell's proposed Caroline gas plant at Site E would be approximately 2 km long. The associated compressor was applied for by Altana and would be installed at the Altana gas plant. Although Husky has not applied for a pipeline to transport acid gas from the existing Altana gas plant to Husky's proposed Site E gas transmission plant, arrangements have been made to accept the Altana acid gas at Husky's plant if its project is approved.

Due to the technical soundness, lack of opposition to the selected pipeline routes, and the relatively minor environmental impacts of these associated applications, the Board considers them to be acceptable. The Amoco condensate pipeline and the Altana acid gas pipeline proposals would follow the same route regardless of which project was to be approved. Even though there is some possibility of ROW sharing with Amoco in the Shell proposal, there are no significant differences between the Shell and Husky applications.

13.3 Future Applications

The NOVA Caroline proposal for the Shell project would consist of meter station facilities which the Board believes would include a short 250-m pipeline. All construction of the facilities would likely take place on unoccupied Crown land and would not involve any watercourse crossings. The estimated capital cost of the NOVA Caroline proposal is $1 550 000.

The NOVA Ram River proposal for the Husky project would require about 16 km of 660-mm OD lateral pipeline loop and meter station facilities. Regardless of which project is approved, the lateral loop and the meter station expansion will be required, although the pipeline would be down-sized to 508-mm OD if the Ram River gas plant is not approved to process the Caroline gas. The proposed pipeline would cross Vetch Creek and several other small unnamed watercourses, but the incremental environmental effects of a 660-mm OD pipeline as compared to a 508-mm OD pipeline are considered negligible. The estimated capital cost of the NOVA Ram River proposal is $3 490 000.

TransAlta has submitted preliminary proposals for the electrical power supply facilities much of which would be common for both the Husky and Shell projects. TransAlta, in order to supply this common service, would require an estimated 85 km of new 138-kV transmission line from the Benalto area and associated substation facilities.

With respect to the Husky project, TransAlta would build an estimated 40 km of additional transmission line and associated facilities, to

be brought in from the Strachan and Ricinus areas. It appears that most of this transmission line would follow existing linear developments.

Upon submission of the applications in their entirety, a technical review will be undertaken and specific environmental and landowner or occupant issues, if any, would be addressed.

Notwithstanding that the complete future applications have not been received for these facilities, the Board notes that the Shell proposal would likely involve 250 m of new pipeline construction, while the Husky proposal would involve laying larger pipe in a project that NOVA suggests will proceed in any case. The most significant difference is the requirement for 40 km of additional electrical transmission line for the Husky proposal. Overall, the Board believes this results in an advantage for the Shell project.

13.4 Conclusions Respecting Related Applications

The Board has determined that certain associated and future facilities are required in order to allow either the Husky or Shell projects to function in the most orderly and efficient manner. In addition, environmental and landowner or occupant concerns have not been identified as issues. The Board is therefore prepared to approve those associated applications which would relate to the approved project.

The Board believes that there are no significant differences between the associated applications or the future applications which would preclude or affect the approval of either the Shell or the Husky project.

14 OVERALL CONCLUSIONS RESPECTING THE CAROLINE BEAVERHILL LAKE GAS DEVELOPMENT APPLICATIONS

The conclusions set out in this section of the report have resulted from a full consideration of all of the evidence placed before the Board at the public hearing. That evidence and the reasons for the conclusions are summarized in the preceding sections.

14.1 The Acceptability of the Applications

The Caroline Beaverhill Lake Gas Pool is one of the most significant reserves of natural gas, hydrocarbon liquids, and sulphur that have been discovered in Alberta for many years. The production and marketing of these reserves would provide very substantial economic benefits to the general Caroline region, the province, the country, and the industry. These would include employment opportunities, expenditures for goods and services, and royalties and taxes to the various levels of government. To achieve these benefits, there is a need for a development project, such as the ones proposed by Shell and Husky.

Each of the proposed projects has been carefully designed to meet all relevant provincial standards and regulations. Their design is technically sound and the Board is confident they would meet operating reliability and resource conservation standards.

There would be negative impacts on the environment from either development proposal. However, with appropriate care in operations and adequate monitoring and follow-up mitigative actions, the impacts should not be of major significance or long lasting. There would also be some negative social impacts on the area and on the lifestyles of its residents. With good planning and continuing involvement of the affected public in that planning, the social impacts should not be overly disruptive.

Regardless of which of the proposals proceeds, there would be incremental risks to the safety of the public in the area due to the production, processing, and transportation of large volumes of natural gas containing some 35 per cent H_2S. The risks, although relatively low, would be real, but the special design features incorporated into the proposals, coupled with particular care in operations, should prevent any major accidents. In this regard, it will be important that all operating staff involved in potentially dangerous parts of the development be well trained and continuously aware of the need for care.

Since no guarantee against an accident can be given, a detailed well-designed emergency response plan must be in place, and the operating staff must be able to immediately implement the plan in the unlikely event of an accident. Public involvement will be important in the development of the details of the plan.

The related facilities to move natural gas and liquid hydrocarbons to market and to provide electric power are essential, whichever project proceeds, and would not have serious negative impacts.

Notwithstanding that some negative impacts on the region would result from the development, whether it be by Shell or by Husky, the Board believes that these impacts would be outweighed by the economic benefits which would be experienced. Proceeding with either one of the proposed developments would thus be in the public interest.

Whichever project proceeds, it would be subject to terms and conditions to ensure that

the benefits from the project would be forthcoming and that the negative impacts would be minimized and mitigated to the maximum practical extent.

14.2 A Comparison of the Proposals

Since there is need for only one project to develop the Caroline reserves, and since it has been concluded that either of the two proposed developments would be in the public interest, the Board has made a comparison of the two proposals. In doing so, it has had regard for the various issues which it believes, in this case, constitute suitable criteria by which the public interest can be evaluated. The criteria considered and the sections of the report in which they are discussed are as follows:

- economic efficiency . . . . (Section 5),
- technical feasibility and operating reliability . . . . . (Section 6),
- resource conservation . . . (Section 7),
- environmental impacts . . . (Section 8),
- risk to public safety . . . . (Section 9),
- socio-economic impacts . (Section 10),
- public acceptability . . . . (Section 11),
- future resource development potential . . (Section 12),
- impact of related applications . . . . . (Section 13).

The Board has subdivided many of these criteria into a number of elements which it believes, when combined, give an overall measure of the particular matter. For example, environmental matters include atmospheric emissions, surface water, groundwater, wildlife, fish, vegetation, and soil.

To compare the proposed projects from a public interest viewpoint requires a detailed comparative evaluation of the proposals for each criterion. Not surprisingly, the Board found that each of the proposed projects enjoys an advantage over the other with respect to certain of the criteria or individual elements of a criterion. For some of the criteria, there was essentially no difference between the proposals. As a result, the Board has had to make an overall comparison on the basis of all of the criteria combined, giving appropriate weight to the importance of each element of the public interest.

The Board does not believe that either the comparative evaluation of individual criterion, or the weighting of them, can be carried out in a precise quantitative manner. It has therefore not done so and has made its assessment in a qualitative manner.

Those criteria which reflect the economic efficiency and benefits of the development to society are important ones and deserving of substantial weight in the overall assessment. In the Board's view, the Shell proposal would be most in the public interest with respect to these criteria. This is primarily because the Board does not accept that the capital costs of the Husky proposal would be as low as estimated by Husky, and therefore significantly less than for the Shell proposal. Also, the Board believes that the lack of Owner support and the relatively limited amount of engineering design work currently completed for the Husky project, would result in the start-up for that project being at least 6 to 12 months later than for the Shell project. This delay would affect the present value of the Husky project and result in the Shell project having a slightly higher total present value. For the same reason, the Shell project would provide, in present value terms, marginally greater regional income and taxes to the various levels of government.

Additionally, the Board believes that for the Shell project, there would be a better distribution of the economic benefits through-

out the general region of the development. The Board generally agrees with the view of several participants in the hearing, that those people who live in the immediate vicinity of the gas field and thus are subjected to its negative impacts, should share equitably in the economic benefits which would result from the development. The Board has long been of the view that one of the reasons for opposition to energy developments by the public is that, too often, those directly and adversely affected by a project do not perceive themselves as appropriately sharing in the benefits from the project.

The Board believes the more important remaining criteria are the social impacts of the development, the risk to public safety, and impacts that would occur to the natural environment.

Regarding social impacts, the Board believes the Husky project would be preferable to that proposed by Shell with respect to traffic problems, increased noise, visual impacts, and negative impacts on property values in the area. This results because the Shell project would involve more facilities in relatively populated areas while the Husky project would locate some of the new facilities in a relatively remote area. However, since the Husky project would be identical to Shell's in terms of the wells and gathering system, and would also have a plant, although a smaller one, at the Shell gas plant site, the advantage to the Husky proposal is small.

For essentially the same reason, the Board sees no significant difference between the projects in terms of other social impact elements including odours and fugitive emissions, the need for community infrastructure, conflicts with existing land use, effects on the health of residents in the area, and changes to their lifestyles.

Overall, with respect to these social impacts, the Board sees little difference between the projects, but Husky has a small advantage.

The safety of the public is an important element of the public interest. The Husky project would involve additional lengthy sour gas transmission pipelines, but otherwise would be similar to Shell's in terms of risk to public safety. The risks associated with these transmission pipelines would not be great, an increase of perhaps some 10 to 20 per cent over those of the Shell project, primarily because the sour gas transmission pipelines would be largely located in relatively remote areas. However, this risk is incremental and thus the Shell proposal would have an advantage.

With respect to an emergency response plan, Shell's proposal would be preferable, involving only one operator and fewer control centres. The need for excellent co-ordination of separate response plans would represent a potential source of concern if the Husky project were to proceed.

Overall, in terms of public safety, the Board believes that the Shell project would have an advantage.

The natural environment is also an important element of the public interest. In this particular case, the Board has assessed environmental impacts by considering a number of important biophysical issues. One of these is the emissions of SO_2 to the atmosphere, and it is respecting this matter that the Husky project has its most significant advantage over that proposed by Shell. The Husky project would increase the sulphur recovery at the Ram River plant to accommodate the Caroline reserves, and the higher sulphur recovery would also be applicable to the other gas reserves currently supplying the Ram River plant. The total SO_2

emissions in the general region would thus be significantly reduced.

The reduction of total sulphur emissions to the atmosphere is desirable, but it is important to note that the Board does not agree with some of the interveners that current emission levels represent a risk to human health or livestock in the region. Furthermore, the Board does not agree with one of the interveners that on the basis of the evidence presented at the hearing, trees in the region are already being seriously affected because of sulphur emissions. The exception to this is in the immediate vicinity of the Ram River plant where sulphur dusting and SO_2 from sulphur block fires have caused damage to local vegetation. Processing of the Caroline gas at the Ram River plant could make the mitigation of these existing problems more difficult. This would tend to offset the possible benefits associated with the lower sulphur emissions resulting from the Husky project.

The Board also notes that the evidence at the hearing regarding damage to trees referred to an area relatively close to and downwind of the Ram River plant. The Husky proposal, although it would mean lower total sulphur emissions in the broad region, would not mean lower cumulative sulphur emissions from Husky's facility over the extended life of the Ram River plant. As a result, if tree damage is indeed occurring in the area identified at the hearing, proceeding with the Husky proposal might not alleviate this situation.

The Board is also of the view, as indicated later in this section, that potential future resource developments in the general Caroline-Rocky Mountain House region could further offset the advantage the Husky proposal has in terms of sulphur emissions.

Referring to other environmental aspects, the Board sees a modest advantage for the Shell proposal with respect to impacts on groundwater, wildlife, and soil, and in terms of emissions of oxides of nitrogen. It sees no discernible difference regarding impacts on surface water, fish, and vegetation, or in terms of CO_2 emissions.

Overall, although the Board recognizes the value of the lower regional sulphur emissions which would result from the Husky project, this advantage is offset by a number of other considerations. As a result, in the Board's judgement, the Husky project is only modestly preferable to that of Shell's in terms of the environment.

The remaining criteria also played a significant although smaller role in the Board's evaluation. In terms of resource conservation, the Board believes there would be little difference between the projects regarding the ultimate resource recovery or the energy used in transporting the produced sulphur to market. The Husky proposal would consume less energy in its plant operations than would Shell's, because it would involve oxygen-enrichment technology. Although this would be offset if Shell adopted the same technology, as it said it planned to do in future, it does result in an advantage for the Husky project.

The technical feasibility and operating reliability of a project are also important, and indeed, problems in these areas can increase risks to the public, cause impacts on the environment, and reduce the economic efficiency of a project. Either project would be acceptable from a technical feasibility and operating reliability viewpoint. However, the Board believes the Shell proposal would be more desirable because of the need for fewer facilities which would be located relatively closer together, Shell would use all new facilities as compared to the retrofitting of existing facilities as proposed by Husky, and the use by Husky of oxygen-enrichment technology on a very large scale.

The Board believes there is considerable potential for further resource development in the general Caroline and Ram River foothills region. In this regard, it agrees with Shell that there is a reasonable likelihood that the Bearberry ultra-sour gas reserves will be developed in the foreseeable future. The Shell proposal would be designed, in part, to accommodate these reserves and avoid the possible future need for another gas plant in the area. Although the Husky project could probably handle the Bearberry gas, it would not be as effective and efficient in that regard. For example, there is a fair chance that processing the Bearberry gas in the proposed Shell plant could involve a higher sulphur recovery than would be feasible at Ram River. This would offset the Husky advantage of lower sulphur emissions.

At present there are existing unconnected sour gas reserves in the region and the Board believes that additional sour gas will likely be discovered in the future. The existing Ram River plant is a logical place for processing many of these reserves. Although an expanded Ram River plant processing the Caroline gas could potentially accommodate this other gas, a lack of capacity might require another expansion at Ram River or a new plant in the area. The Board also notes that sufficient new gas going to Ram River could bring about an increase in sulphur recovery at that plant, even without the Caroline gas. Again, this would offset the Husky advantage of lower sulphur emissions.

The Board concludes that the development of a new plant in the Caroline area, as proposed by Shell, would have a clear advantage in terms of planning for future resource development in the region.

Many members of the public participated directly in the hearing, either individually or through group submissions. On the basis of those submissions, the Board has concluded that there appears to be more support in the general area for the Shell project than for Husky's proposal.

Either project would require related facilities to move natural gas and liquid hydrocarbons to markets and to supply electric power. There would be no significant difference in the effects of these related facilities on the respective projects.

In summary with respect to all the public interest criteria, the Husky project appears preferrable in terms of the environment, certain social impacts, and resource conservation. The Shell proposal has advantages in terms of economic efficiency and economic benefits, and likely regarding public acceptability. Shell also has an advantage regarding risks to public safety, technical feasibility and operating reliability, and future resource development potential. Having regard for all of these, the Board concludes that while both proposals would offer substantial benefits, the Shell proposal is the most desirable in terms of the overall public interest. Additionally, it is the preferred choice of the large majority of working interest owners.

Many participants at the hearing made reference to the Board's policy on gas plant proliferation. Both applicants argued that their proposed development would be consistent with the Board's objectives of avoiding the construction of new facilities to support the needs for processing new reserves in an economic and orderly fashion.

The Board is satisfied that approval of Shell's project is consistent with the Board's objectives for encouraging greater regional processing and use of larger facilities. The Board believes that the existing and expected gas reserve base in the general Caroline and

Ram River foothills region would be sufficient to support the long-term use of more than one large plant in the area and would permit the processing of all sour gas reserves at the highest level of sulphur recovery efficiency. The Board's policy on plant proliferation is not intended to direct that gas be processed at a single central facility over an area beyond prudent bounds, or to disregard the varied interests involved in orderly development. New development should strike a sound balance between public and private interests, and the Board believes that Shell's project does strike such a balance.

15 DECISION

The Board, subject to receipt of the necessary approvals from the Minister of the Environment with respect to environmental matters, hereby approves Applications No. 890969, 891504, 891505, 891506, 891478, 891479, 891480, 891481, 891482, 891568, 891569, 891570, 891571, and 900404 submitted by Shell Canada Limited, Application No. 891483 submitted by Federated Pipe Lines Ltd., Application No. 891290 submitted by Amoco Canada Petroleum Company Ltd., and Application No. 900236 submitted by Altana Exploration Company. These applications constitute the Shell project and their approval would be subject to the conditions described in Appendix A.

DATED at Calgary, Alberta on 31 August 1990

ENERGY RESOURCES CONSERVATION BOARD

G.J. DeSorcy, P.Eng.
Chairman

B.F. Bietz, Ph.D.
Board Member

F.J. Mink, P.Eng.
Board Member

APPENDIX A

Terms, Conditions, and Provisions of Approvals

1. Adherence to all of the applicable standards and requirements for oil and gas facilities in the province of Alberta.
2. Discharge of all of the undertakings included in the applications or given by the applicants at the hearing.
3. Achieve an annual average sulphur recovery level of 99.8 per cent and a minimum quarterly average recovery of 99.5 per cent.
4. The following special requirements which arise from the hearing and this decision:
   - The effectiveness of the leak detection systems proposed by Shell must be monitored and reported on to the Board.
   - Shell must provide the Board, in its Part II gas plant application, further details respecting its planned sweet gas purge systems.
   - Shell will be requested to further review the energy efficiency, economic, and operating reliability aspects of utilizing oxygen-enrichment technology at its plant to process the Caroline reserves, and submit its findings to the Board.
   - All facilities must meet or exceed the noise control guidelines of ERCB Interim Directive *ID 88-1*.
   - Shell must consider the feasibility of placing its fresh water supply line from the James River in the same right of way as planned for the Amoco condensate pipeline.
   - Detailed designs must be completed for all pipeline stream crossings and are to be submitted to Alberta Environment and the Board for review prior to construction.
   - Hydrogeological and other related studies must be conducted by Shell at the proposed Shantz sulphur forming site. A detailed design must be completed which will ensure adequate protection for surface and groundwater and is to be submitted to Alberta Environment and the Board for review prior to construction.
   - Shell must complete a satisfactory detailed emergency response plan and submit it to the Board for approval. The plan must include involvement of the public in its preparation, preferably through an Emergency Response Awareness Committee which would include representatives of a broad cross-section of the public in the affected area. The plan must address the problem of single road access, an appropriate warning system for Burnstick Lake residents, and the provision of monitoring equipment and an early alert system for the Brunner residence. The plan must cover a zone with a radius of 4 km, but also include the nearby population centres of Sundre, Burnstick Lake, and the Westward Ho area. The plan must also include a further 4-km awareness zone. The response plan must include an ignition policy accep-table to the Board with respect to a possible uncontrolled flow from a well.
   - A background and operations-related monitoring program acceptable to the Board must be developed through discussions between Shell, representatives of the affected public, Alberta Environment, and the Board. Monitoring in accordance with the program must be carried out and the results must be made public. The monitoring program should also include the gathering by Shell of detailed meteorological data for the area.
   - Shell must develop, with appropriate input from government departments, a program to accomplish the committed

to no-net-loss policy with respect to wildlife and fish habitat. Periodic reporting must take place respecting the success in implementing the program. Consideration should be given, in concert with appropriate government departments, to a program to gather baseline data of wildlife species in the area of the project.

- Shell must work with local communities to ensure the availability of adequate social infrastructure for health, security, and other services.
- Shell must endeavour to employ local residents and also establish communication links with local high schools to ensure they are aware of work opportunities and required training.
- Involvement with the public in the area must continue to ensure the public is aware of Shell's on-going plans. Also, a system for registering concerns and complaints, and for effective investigation of them, must be in place.
- Efforts should be made by Shell to schedule work shifts and other activities in a manner which would minimize potential conflict with school bus schedules.
- A program should be developed by Shell to provide an on-going audit of the success of the EIA and the SEIA in predicting impacts, and the effectiveness of on-going activities to mitigate those impacts.

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